THE JOURNAL

OF THE

ROYAL AERONAUTICAL SOCIETY

(FOUNDED 1897 in succession to the ANNUAL REPORTS)

Edited for the Council by J. LAURENCE PRITCHARD, Fellow

No. 165 SEPTEMBER, 1924 VOL. XXVIII

NOTICES

Associate Fellowship Examination

The time-table for Part II. of the Associate Fellowship Examination, which is to be held in the Library at 7, Albemarle Street, on Tuesday, September 23rd, will be as follows:—

10.0 a.m. to 1.0 p.m.—Strength and Elasticity of Materials and Theory of Structures.

2.30 p.m. to 5.30 p.m.—Aerodynamics. Heat Engines.

Civil Aviation Advisory Board

A letter has been received from the Air Ministry announcing the dissolution of the Civil Aviation Advisory Board and expressing the thanks of the Air Council to the Society for the valuable assistance rendered by its representative, Lieut.-Colonel Mervyn O'Gorman.

The Board was created in 1922 "To advise generally on the development of Civil Aviation and to report upon any specific point which may from time to time be referred to the Board by the Secretary of State for Air," and has issued two reports: "First Report on Imperial Air Mail Services," 1922, and "Report on Aerodrome Facilities of London," 1923.

Library

The following books have recently been received and placed in the Library:—"The Spider Web," by "P.I.X."; "The Times Atlas"; Technical Reports of the Advisory Committee for Aeronautics, 1916-1917, 1917-1918, 1918-1919; Report of the National Advisory Committee for Aeronautics of America for 1922; "Instruments for Aerial Navigation," by A. J. Hughes; "The Investigation of the Maximum Temperatures and Pressures Attainable in the Combustion of Gaseous and Liquid Fuels," by G. A. Goodenough and G. T. Felbeck; "The Year Book of Wireless Telegraphy," by the Wireless Press, Ltd.; "Resources of the Empire: Communications," by W. T. Stephenson; "La Guerre au Vingtieme Siècle," by A. Robida; "The Defence of London, 1915-1918," by Colonel A. Rawlinson; "Flying and Sport in East Africa," by L. Walmsley; "The Queen of Sheba and her only son Menyelek," by Sir E. A. W. Budge; "De Bello Belgico," by F. Strada; "Aeronautical Prints and Drawings," by Colonel Lockwood Marsh; Abridgements of Specifications of Patents for Aeronautical Inventions, 1905-8, 1909-15, 1916-20.

Forthcoming Arrangements

Tuesday, September 16th, 5.30 p.m.—Council Meeting.

Thursday, October 2nd, 5.30 p.m.—*Society's Library.* Colonel H. T. Tizard, Inaugural Lecture.

Thursday, October 16th, 5.30 p.m.—*Royal Society of Arts.* Dr. A. Rohrbach, "Large All-Metal Seaplanes."

W. Lockwood Marsh, *Secretary.*

PROCEEDINGS

TWELFTH MEETING, 59TH SESSION.

The final meeting of the 1923-24 Session of the Royal Aeronautical Society was held at the Royal Society of Arts, John Street, Adelphi, London, on Thursday, April 3rd, when a paper on "The British Aviation Mission to the Imperial Japanese Navy" was read by Colonel the Master of Sempill, A.F.C. (lately Acting Captain, Imperial Japanese Navy, and commanding the British Aviation Mission). The meeting was a notable one, in view of the large number present, which included numerous representatives of Japan, and many representatives of the British aeronautical world, and their ladies.

Colonel A. Ogilvie (Chairman of the Society) presided.

THE BRITISH AVIATION MISSION TO THE IMPERIAL JAPANESE NAVY

BY COLONEL THE MASTER OF SEMPILL, A.F.C., A.F.R.AE.S.

(LATELY ACTING CAPTAIN, IMPERIAL JAPANESE NAVY AND COMMANDING BRITISH AVIATION MISSION).

References in Japanese Mythology and History to Flying

Japanese mythology (*i.e.*, prior to the sixth century B.C.) seems to contain no reference to flying. There is therefore no close parallel to the story of Dædalus and Icarus with which we are familiar. There are, it is true, many references to the descent from Heaven of gods and goddesses, but no details are given.

One of the very ancient "No" plays tells of an angel descending from the sky at Tago-no-ura wearing wings made from the feathers of the crane (Tsuru). Being somewhat tired after her flight, she removed her wings, which were stolen by a fisherman. On discovering her loss, her distress was such as to move the fisherman to return the wings, which he did on the condition that the angel would dance for him before flying away. This dance (Hagoromo-no-Mai) is one of the most graceful found in the "No" plays.

There is also, of course, the story of the priest Kume-no-sennin, recently referred to in a Japanese newspaper as follows: "If aviation continues to make such rapid strides in this country we shall be putting up notices on the river banks reading 'It is forbidden to wash clothes here.'" The explanation is as follows: Kume-no-sennin lived many centuries ago, and by dint of prayer and fasting, and in general depriving himself of the agreeable things of life and concentrating entirely on spiritual matters, acquired magical powers, amongst them being the power of levitation. One day he was soaring over a river and perceived a very beautiful girl washing clothes in the stream. Struck by her great beauty, he allowed his thoughts to wander, and losing the powers he had acquired fell with fatal results.

There is also the story of En-no-Shokaku (about A.D. 650), who escaped the executioner's axe by levitating himself up into the sky.

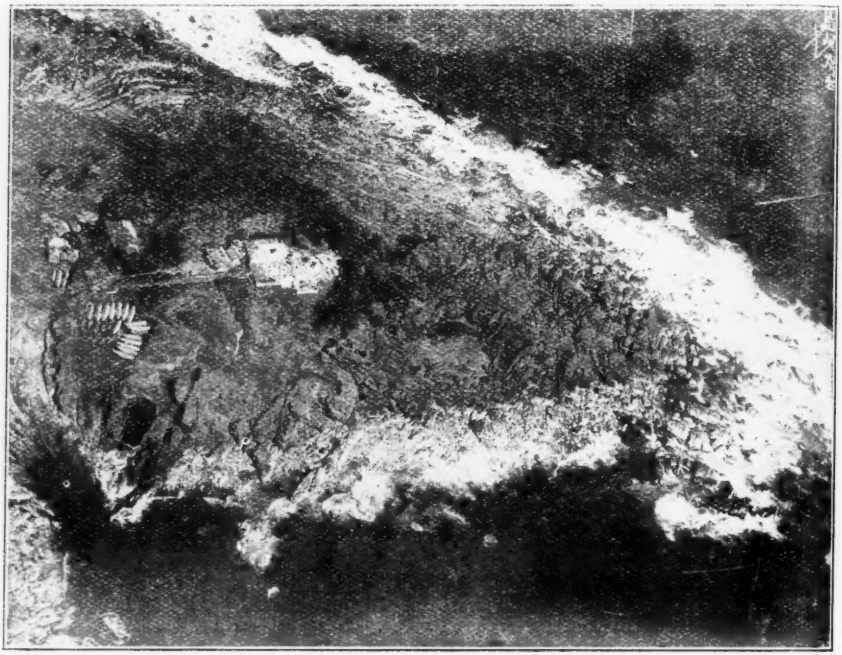
The man-lifting kite was evidently used some centuries ago, as one Ishikawa Goemon used such a device in an endeavour to steal the two golden dolphins from the roof of Nagoya Castle.

In Tokyo, some one hundred years ago, a man commenced experiments with a glider, but unluckily made a bad landing and completely wrecked his machine

in front of the train of a great feudal Lord or Daimyo. The Daimyo was so incensed at his very " unnatural and devilish " act that he had him executed.

British Influence in Japan

Contact between Great Britain and Japan has occurred spasmodically from the sixteenth century. Will Adams, known as the first Englishman to ever reside in Japan, was a " pilot major of a fleete of five sayle " and an experienced ship-builder. He became the trusted confidant of Ieyasu Tokugawa, the first of the great Tokugawa Shoguns (the title literally meaning generalissimo; the Shoguns were, in fact, the virtual temporal rulers of Japan), and may in a sense be described as the first Englishman to have to do with the building up of the Japanese Navy of that day.

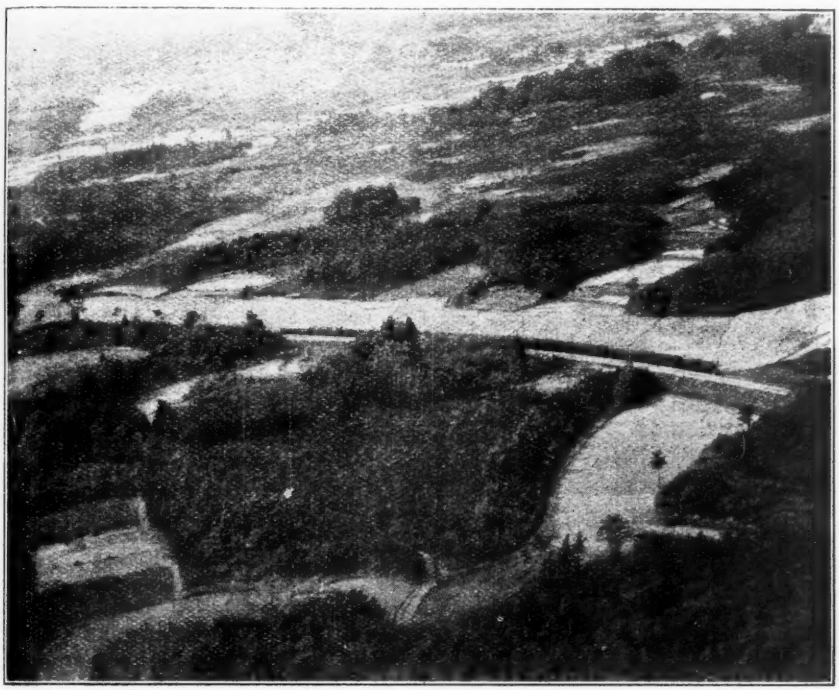


September 1923, air survey of stricken areas. Wrecked Lighthouse at entrance of Tokyo Bay.

The foundation of the modern Japanese Navy dates from 1867, when the British Government loaned the services of Commander Tracey, R.N., and a number of naval officers and ratings. This Mission did not last more than six months, as the Revolution which restored the Emperor to full temporal as well as religious power broke out and Commander Tracey and his party were withdrawn to England. The late Admiral of the Fleet Sir Arthur Wilson, then Lieutenant, served on this Mission.

During the Revolution, however, one of the great Princes conceived the idea of a having a navy of his own, and engaged Lieutenant A. G. S. Hawes, R.M.L.I., primarily as gunnery instructor. This officer had great organising ability, and has been acclaimed by some as the real father of the Japanese Navy.

In 1873, when the country had settled down, the British Government lent the services of a second Naval Mission headed by Commander Douglas, R.N., afterwards Admiral Sir Archibald Douglas, R.N., which consisted of thirty officers and men. This Mission remained in Japan for six years and was responsible amongst other things for the foundation of the first Naval College in Tokyo. I was interested to learn by chance not very long ago that the general organisation of the British Aviation Mission was almost identical with that of the second Naval Mission.

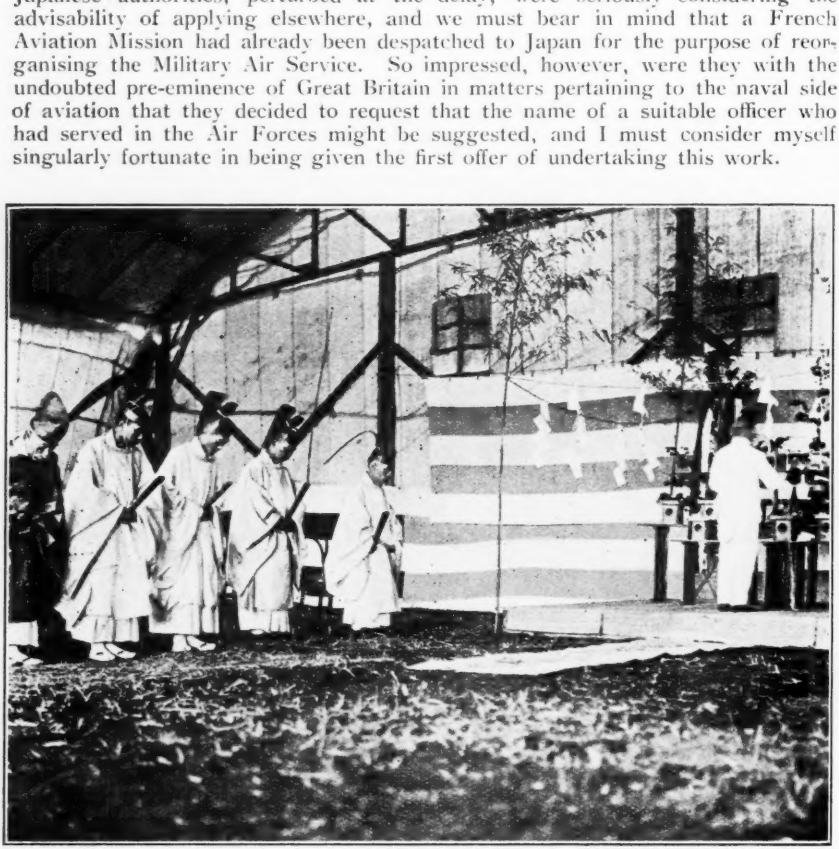


Prior to clearing, the aerodrome was covered with obstructions similar to those in the above photograph.

Influences Leading to the Formation of the British Aviation Mission

During the late war, it is no idle boast to say that the Japanese Navy became impressed with the work of our own Naval Air Service and convinced of the necessity of having a similar organisation. Admiral Baron Kato, I.J.N., then Minister of the Navy, known to all as the Chief Japanese Delegate at the Washington Conference, decided to approach the British Government through the usual channels for assistance. It can well be realised that in view of the very close relationship on naval matters which had always existed between the two countries, with admirable results, such a decision was a most natural one. In 1920 official application was made for the loan of the services of an Aviation Mission composed of personnel seconded from the Royal Air Force. The request no doubt came at an awkward time, as the endeavour then was to clear up after the war and reorganise the fighting services on a peace basis. Several departments of

State had a voice in such a matter and a decision was long delayed. From the Japanese aspect this was serious, particularly as no indication was given that the request would be acceded to at all. Eventually a reply was sent regretting that the British Government was not in a position to render the assistance required, mainly on the grounds of extreme shortage of personnel. At this time the Japanese authorities, perturbed at the delay, were seriously considering the advisability of applying elsewhere, and we must bear in mind that a French Aviation Mission had already been despatched to Japan for the purpose of reorganising the Military Air Service. So impressed, however, were they with the undoubted pre-eminence of Great Britain in matters pertaining to the naval side of aviation that they decided to request that the name of a suitable officer who had served in the Air Forces might be suggested, and I must consider myself singularly fortunate in being given the first offer of undertaking this work.



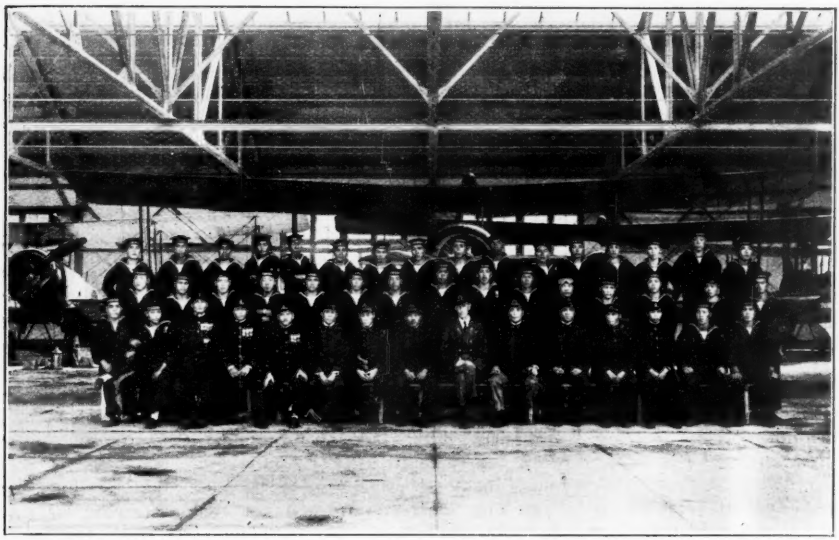
Shinto ceremony at opening of the I.J.N. Air Station "Kasumigaura" (see propeller on altar), July, 1921.

In January, 1921, I came to an agreement with Rear-Admiral Kobayashi, then the Naval Attaché, and actually commenced the organisation of the British Aviation Mission on the first of the following month. The Japanese authorities, very wisely realising that we had experience that would be peculiarly valuable to them, placed no major restrictions whatever in regard to the organisation of the Mission, which was charged with the reorganisation, equipment and training of the Imperial Japanese Naval Air Service.

Certain types of aircraft, *i.e.*, the Avro and F.5, had already been ordered in small quantity, but there were no other commitments.

The Mission was composed almost without exception of personnel who had been in the Royal Naval Air Service, as they naturally possessed the particular experience which was desired. The staff numbered thirty, there being eighteen officers and twelve warrant officers (second class). The organisation was similar to that in the Royal Naval Air Service, and in consequence conformed very closely indeed to that of the Japanese Navy. The Japanese Admiralty granted acting commissions to all members with ranks equivalent to those they had already held previously in the British Air Service

A suitable uniform was required, and it was considered desirable that a special design should be got out to meet the particular conditions. The design chosen was similar to that of our own Naval Air Service, with the main difference that a colour more suitable to the conditions met with on an aerodrome was adopted. My listeners will sympathise with me in the difficulties with which I was confronted in my endeavour to discover the ideal uniform for an air service, particularly those who are familiar with the heroic and prolonged efforts that have



The Avro Flight (A) (permanent brick and steel hangar, 180ft. × 80ft.).

been made by the sartorial experts of our own Royal Air Force to arrive at a satisfactory solution of this difficult problem.

The original agreement was for one year, but it was clearly realised on both sides that such a period would have to be considerably extended. It was, in fact, pointed out that, so far as could be seen, work of this nature would occupy about five years, but under no circumstances less than three. As it transpires, over three years have been spent, approximately 70 per cent. of which time in an executive capacity and 30 per cent. in an advisory. The reason for such differentiation must be obvious, as the idea of the final advisory period was that the Japanese personnel so far trained should run the Service on their own with a small percentage of instructors in the background.

To digress for a moment, it would be interesting to consider the progress of aviation in Japan in the last few years. The first aeroplane was flown on

December 14th, 1910, by Captain K. Hino of the Japanese Army; this was a Hans Grade Monoplane. Shortly after this, certain naval officers took up aviation, and in most cases they were trained in America and France. It was not, however, until during the war that serious attention was devoted to aviation, but no extensive action could be taken until 1919. The first steps were taken by the Army, who arranged for a French Military Aviation Mission. You will, of course, be aware that the French and Japanese Military General Staffs were in very close co-operation at that time, and in fact the Army is being reorganised in the light of French experience during the war. This Mission stayed in Japan some two years and was under the command of Lieutenant-Colonel Faure.

Their headquarters were at Tokorazawa, the principal training school of the Japanese Military Air Service, on the outskirts of Tokyo. The principal machines and engines in use by that Service, many of which are now built in the Military Arsenal adjoining the aerodrome or by commercial concerns such as the Kawasaki Dockyard Co., Ltd., in many cases under French licences, are Nieuport, Breguet, Salmson and Farman, the engines being chiefly Salmson, Le Rhone and Hispano Suiza.

The organisation of the Military Air Service is somewhat similar to that of our late Royal Flying Corps, there being a Department of Military Aeronautics with a Director-General at the head. It is interesting to note an increasing tendency to use British equipment, and it is believed such will become more common in the near future.

Commercial aviation has so far made little progress. The first organised air route over a short distance commenced operating in December, 1922, carrying mails and goods. In January of the following year a service for carrying goods and mails between Tokyo and Osaka was inaugurated, the distance being about 250 miles. The recent earthquake has put an end to this service for the moment. Naval and military aircraft rendered splendid service when all the means of communication were paralysed during the period immediately following the earthquake. Apart from the carrying of despatches and mails, photographic surveys of the stricken areas were carried out.

The Imperial Aero Society of Japan, which combines the functions of our Royal Aeronautical Society and Royal Aero Club in so far as competitions are concerned, is throwing itself with great keenness into the task of popularising aviation, and I must here recall, with deep gratitude, that they treated the Mission most hospitably on many occasions, and were good enough to consider that our services to Japanese aviation were such as to warrant the conferring of the Society's gold medal and diploma.

Air Organisation in the Japanese Admiralty

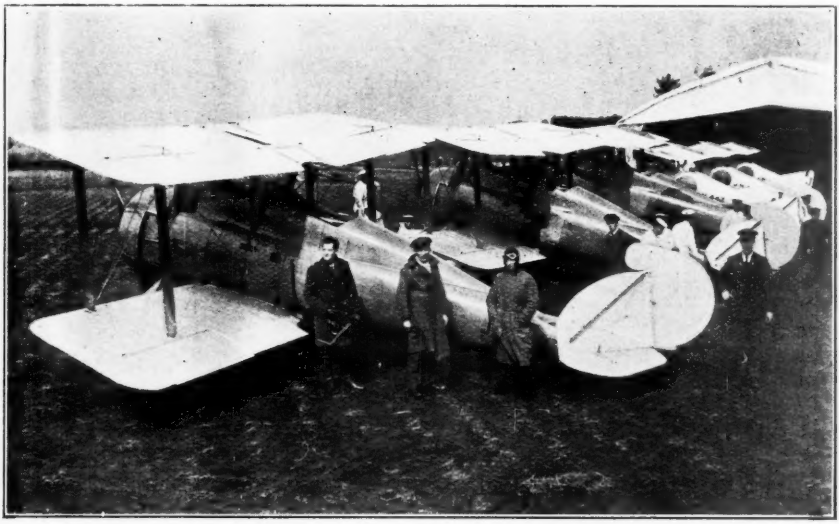
In the Japanese Admiralty there is at the moment no separate Air Department, but there are sections in the principal departments appointed to deal with aircraft matters. The work of these various sections is co-ordinated by the Minister of the Navy.

The Admiralty Departments having sections dealing with aircraft questions are: The Naval General Staff, the Bureau of Supply and Research, the Bureau of Military Affairs, and the Bureau of Education. It is only recently, however, that the Naval General Staff have had an Air Section, to which are attached officers who have had a certain amount of air experience. The Sixth Section of the Bureau of Supply and Research deals with aircraft material generally, and is in charge of a Rear-Admiral. The Third Section of the Bureau of Military Affairs deals with policy, etc., and is in charge of a Captain. The Air Section in the Bureau of Education deals with training.

Now that the Air Service is growing so rapidly the disadvantages of the system described above may be appreciated, although it was no doubt well suited to the administering of the air side of the Japanese Navy as it existed some years back.

Air stations generally are administered under a Commander-in-Chief, as is the case with ordinary Admiralty establishments. In special cases, such as for air training stations, an officer may be appointed in command being directly responsible to the Minister of the Navy.

Plans have been put forward for the creating of a Naval Air Service, manned by personnel seconded from the Navy, or in certain instances obtained by direct entry. This would necessitate the creation of a Naval Air Department, the head of that department being directly responsible to the Minister for all air matters, the closest liaison being kept with the N.G. Staff and other departments as circumstances dictated. It would take too long to go into the details of such a



Panthers and Sparrowhawks leaving Kasumigaura for fleet course at Yokosuka Naval Base.

scheme at this time, but it may be remarked that as an Air Service is so largely dependent on technical organisation, every arrangement would be made to encourage officers and men to specialise in the various branches, such as engineering, armament, photography, etc., and the fundamental necessity of providing attractive careers for such personnel in these branches will not be lost sight of. Such a policy has, in fact, already been brought into force, at least to some extent, and will be considerably extended.

The well-known controversies that have raged round Air Service organisation have occurred in Japan and there was at one time a serious move towards a unified and separate Air Service. This emanated from the Military Air Service, but it may be remarked that such an idea was at no time very popular with those on the naval side.

The late Admiral Baron Kato, the Prime Minister and Minister of the Navy, who was Chief of Staff to Admiral of the Fleet Count Togo at the famous battle

of Tsu Chima, and Admiral Yamashita, the Director of Operations at that time and now Chief of the Naval General Staff, were very wisely strongly opposed to such a suggestion, in view of the divergent policies and different system of the Military Air Service and for other important reasons.

Organisation of the Mission

The Mission was divided into four principal sections:—Flying, Technical, Armament and Photography. In addition to the staff under the above heads there was a medical officer and first lieutenant and a W.O. writer.

Commanding Officer, Captain The Master of Sempill.
Second in Command, Commander C. L. Meares.
Medical Officer, Surg.-Lieut. W. F[illegible]
Executive Duties, S./Lt. R. M. B[illegible]d.
W.O.2 J. Hunter.

TECHNICAL.

O. i/c., Lt.-Cdr. F. C. Atkinson.

Engines.
S./Lt. A. S. Sheret.
W.O.2 H. G. Crisp.
,, G. Redmond.
,, E. J. Adams.
,, W. T. Ellis.
,, M. B. Ford.

Aircraft.
S./Lt. E. C. Landamore.
W.O.2 W. R. E. Satchell.
,, A. R. Williams.
,, J. Bond.
,, W. A. Earwaker.

Design and Inspection.
S./Lt. G. R. Volkert.
W.O.2 F. E. Sherras.

Technical Instruction and Parachutes.
Lt.-Cdr. T. Orde Lees.

FLYING.

O. i/c., Lt.-Cdr. F. B. Fowler.

F5 Flying Boats and Seaplanes.
Lt.-Cdr. H. G. Brackley.
Lieut. [illegible] M. Bryan.

Scouts.
Lieut. R. Vaughan Fowler.

Preliminary Training.
Lieut. A. G. Loton.

Ship and Torpedo Planes and Fleet Co-operation.
Lt.-Cdr. C. H. C. Smith.

ARMAMENT.

O. i/c., Lt.-Cdr. H. J. Eldridge.
Asst., S./Lt. A. W. Hatfield.

PHOTOGRAPHY.

O. i/c., Lieut. W. Pollard
Asst., W.O.2 S. Manton.

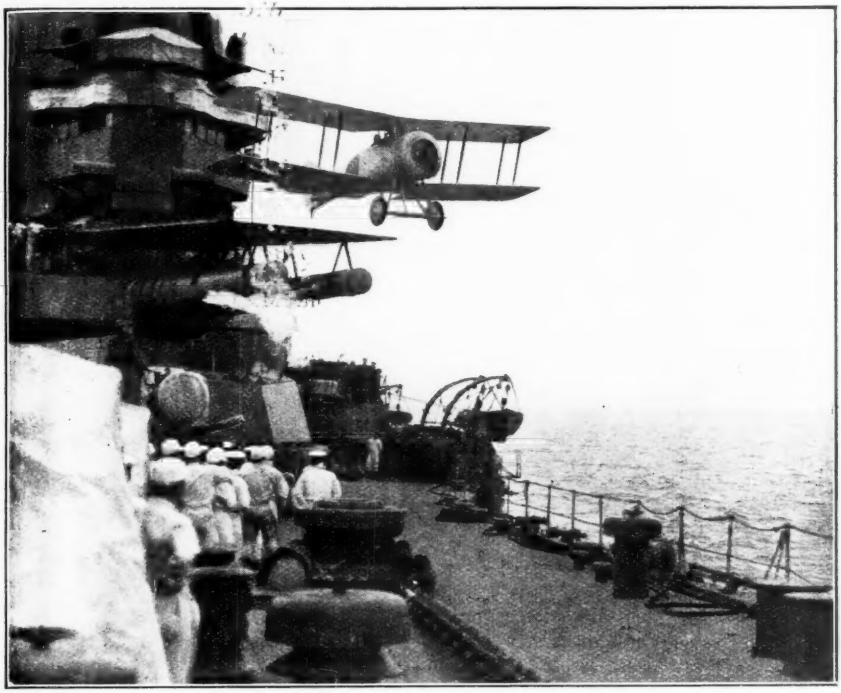
Every section was in charge of a thoroughly experienced officer, and the organisation can be followed by studying the above table.

It naturally took some time to get together the necessary personnel, many of whom could not be secured at once. By the middle of March, however, the bulk of them had been obtained.

Whilst it was necessary to keep back a number of officers to assist in obtaining the material required, it was possible to despatch an advance party under the Second in Command, including three flying officers and two engineer warrant officers, on 12th March by quickest route via America. The rest of the personnel sailed in batches, via the Ports, as preparations on this side advanced. It can well be realised that the vast quantity of material of every description that was required took a considerable amount of time to purchase, inspect and ship.

The advance party arrived in Japan in the middle of April and proceeded at once to inspect the site proposed for the new Central Training Station of the Naval Air Service. The activities of the Mission were concentrated chiefly at this station —Kasumigaura, meaning "Lagoon in the mist"—which lies on the shores of a lagoon of the same name about forty miles N.E. of Tokyo.

The site had been well chosen, as was quite evident from the preliminary inspection of the ground marked out, and whole-hearted approval was given. The aerodrome lies about one mile from the shores of the lagoon on a raised plateau and is of very generous dimensions. The area at the present moment available for landing on is about seven hundred acres, and there are excellent facilities for expansion to over double that area when such is found necessary. I do not propose to go into further details of the lay-out of the aerodrome as these can be so much more readily appreciated from a few slides I have to show.



H.I.J.M.S. "Yamashiro" under way in Tokyo Bay.
Fleet type Sparrowhawk taking off.

Arrangements were made on the shores of the lagoon for the building up of a seaplane station suitable for preliminary training. The lagoon is not tidal and is of vast area, covering over 60 square miles, being some 25 to 30 miles in length with an average width of three to four miles and offering unique facilities for training purposes with seaplanes and flying boats.

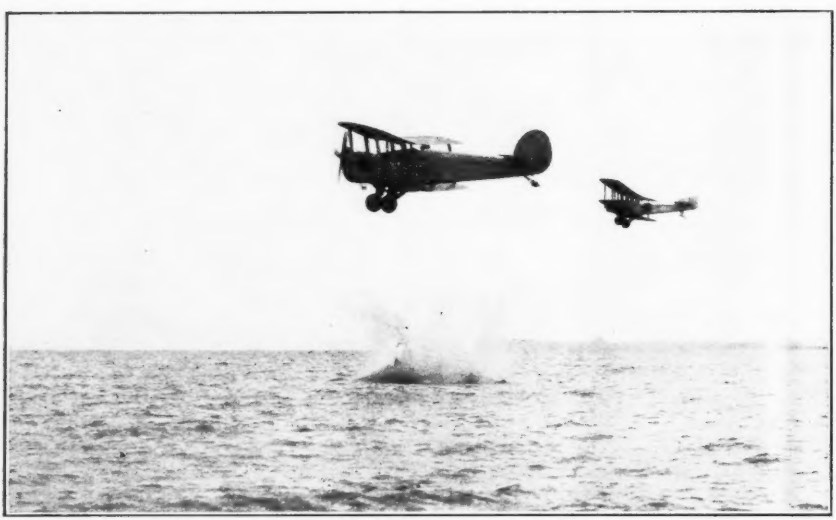
A light railway was constructed for bringing in stores from the nearest railway station. Communication for personnel between the railway and air station was by road or water.

Very excellent quarters were specially constructed for the Mission with every possible facility, including a billiard-room with two full-size tables and tennis courts adjoining.

As has already been mentioned, certain Avro machines and F5 flying boats had been ordered. This was unfortunate in some respect as it committed us to

using the F5 type of flying boat which, although undoubtedly an excellent machine in its day, had been superseded by a more modern type in the P5. The Avros were naturally useful as this machine had been selected for preliminary training.

It was most important to select types of machines which could be easily obtained, as it was necessary to have them shipped to Japan at the earliest moment. Equipment was obtained from many firms such as Messrs. Armstrong, Whitworth Aircraft Co., Blackburn Aeroplane Co., Gloucestershire Aircraft Co., Supermarine Aviation Co., Vickers, Ltd., Rolls-Royce, Ltd., Napier and Sons, Ltd., Geo. Parnall and Co., Short Bros., A. V. Roe, Ltd., Disposals Company, Nobel Industries, Ltd., Monarch Engineering Co., Butchers, Yorkshire Steel Co., Metal Air Screws, Ltd., etc., etc.



Torpedo dropping practice on the lake (Swift and Cuckoo).

The types of machines selected were as follows:—

Preliminary Training.

Preliminary training for all pilots, Avro 504K with 110 Le Rhone.
Preliminary seaplane training, Avro 504L with BR1.
(Chosen so as to avoid multiplication of different types.)

Scout Training.

Sparrowhawk with BR2. (These machines were Nighthawks originally destined for the unsuccessful Dragonfly radial engine, but were modified so as to take the BR2, a type of engine immediately available.)

Flying Boat Training.

Preliminary flying boat training, supermarine "Channel" type with Siddeley "Puma."
Flying boat training, F5 fitted with 2 Eagle VIII.

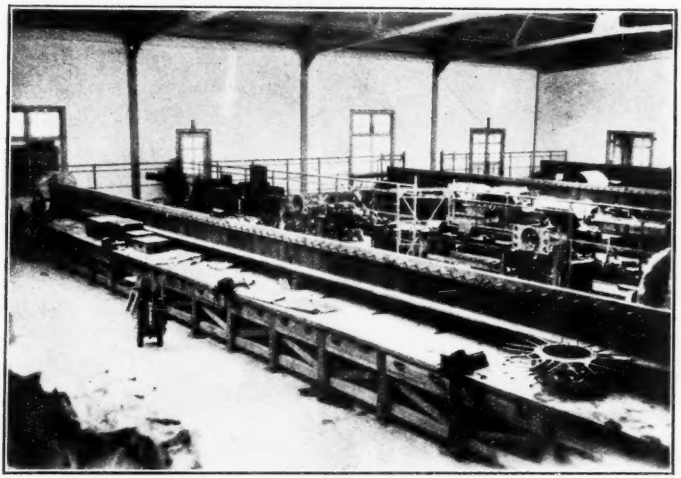
Fleet Co-operation.

Fleet spotting and deck landing, Panther with BR2, also fleet type Sparrowhawk.
Torpedo dropping, Cuckoo with Viper engine.

In addition to the above machines several of the latest types were taken out with a view to experimenting with them under actual service conditions in Japan. These were Blackburn " Swift " Torpedo Carrier, Supermarine " Seal " Amphibian Fleet Spotter and Vickers' " Viking " Amphibian Fleet Spotter.

In all approximately 200 machines were ordered in the first instance. These orders were supplemented at a later date from Japanese as well as British sources. In addition to engines fitted into machines, some " Lynx " engines were ordered for fitting into Avros with a view to utilising this engine for training purposes. It was also proposed to utilise the Jaguar in the Scout machine, the Sparrowhawk, provision being made for it, thereby entailing the minimum of alteration. The advantage of having two engines of similar type wherein certain parts are common may be well appreciated.

A few types of machines in common use during the war were also taken out as samples of prominent Service types, such as SE5a, D.H.9, Martynside F4, etc., also various types of engines for instructional purposes.



General view of Engine Shop.

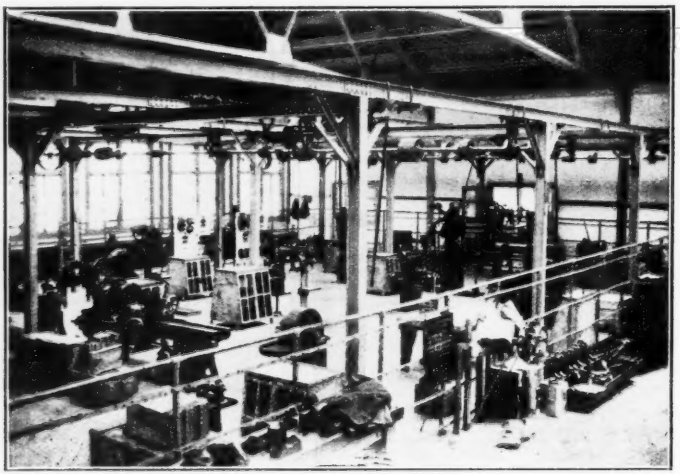
In addition to the actual machines and engines required, a vast amount of material had to be arranged for, such as spare engines, aircraft and engine spares, spare floats for seaplanes, propellers (wood and metal), Hucks' Ford starters, electrical equipment, instruments, dopes and fabrics, A.G.S. parts, tools, bolts and nuts, oil, P.R. tubing, sparking plugs, armament and photographic supplies, medical equipment, and the hundred and one things which go to the making of a fully equipped Air Service.

Preparations in Japan

As has already been mentioned, the advance party arrived in the middle of April, and between that time and the end of July the rest of the personnel arrived. At the end of July, with the exception of one officer who had been left behind to complete purchases and inspection and despatch of material, the whole Mission was on the spot. Those concerned were naturally extremely occupied in the first instance in getting out plans of the various buildings, flight hangars, workshops, armament and photographic buildings, etc. The preparation of the aero-

drome entailed a large amount of clearing, levelling and draining, and this together with the construction of all the buildings referred to was carried out by the Works Department of the Admiralty, in accordance with our general recommendations. The progress of the work was astonishingly rapid, particularly when it was realised that in April, 1921, nothing existed, the main area being covered by trees and fields. As soon as an area of roughly fifty acres had been prepared preliminary instruction on Avros commenced for the purpose of teaching the picked Japanese pilots, who had been nominated as assistant instructors, the Gosport system of preliminary flying training.

The official opening of the aerodrome at the end of July was preceded by a Shinto ceremony consecrating the ground to the use of the Imperial Forces. It is interesting to remark that a propeller was placed on the altar as an emblem suitable to the occasion. As an indication of the interest taken in flying, it may be mentioned that there were present on this occasion upwards of thirty thousand spectators, many of whom had walked great distances.



General view of Machine Shop.

The first course of instruction commenced on September 1st with twelve probationary flying officers, one of whom was a military officer being specially trained at the request of the War Office. Since that date training has progressed without intermission and of course the number of officers under instruction has gradually increased as additional facilities became available. Courses of instruction were carried on concurrently for engineer officers, armament and photographic and other various specialist officers, as also for warrant officers, petty officers and ratings.

As already mentioned, the organisation of the Mission was split up into four principal sections and I will endeavour to outline generally their scope. Before doing this I had better explain that prior to the commencement of our work the Navy only had one type of machine, a two-seater float seaplane, and one small seaplane station. The quality of the equipment generally was on a level with that of our own Naval Air Service when first created.

Airships

Although our work was primarily concerned with heavier-than-air craft, I must mention that airships have received continued attention since first introduced into Japan, but so far little money has been available. Certain officers in the Naval Airship Service were trained in our own Service when that existed. The most recent acquisition is a small ship of the Astra Torres type, fitted with Sunbeam engines. The S.S. twin type has been used, but have met with bad luck. There are a few kite balloons of English and Italian design.

The Seal fleet spotter.

Accustomed as we are to seeing rigid airship sheds in process of demolition or decay, it was most refreshing to watch the completion of a large shed of this nature adjoining the aerodrome at Kasumigaura. At present, however, it houses the Astra Torres, almost lost in its vast dimensions. The Military Air Service also has an interest in airships of the smaller variety.

Helium is to be found, but in very small quantity, the highest percentage being .2 per cent.

At present there are no mooring-masts in existence.

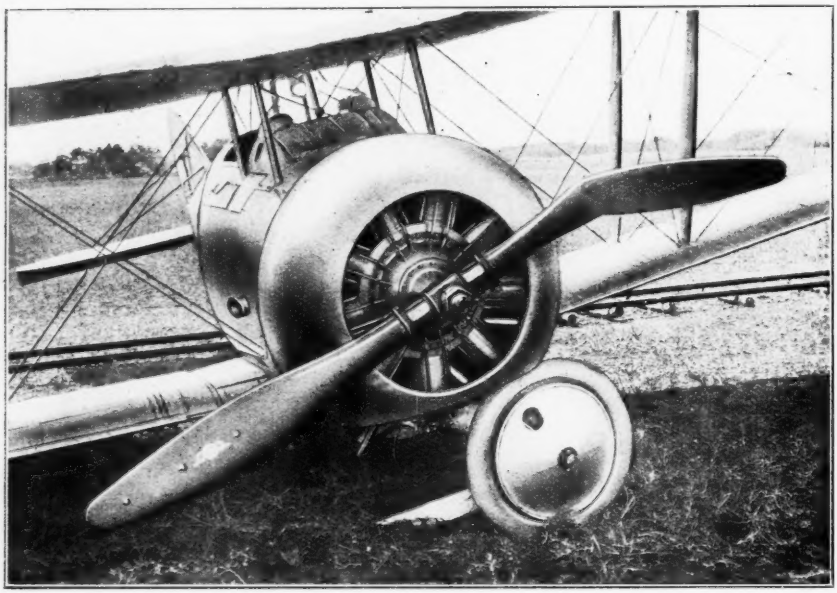
Flying

The Flying Section of the Mission was composed, as you have already gathered, of six officers; one in charge, one for preliminary training, one for flying boats, one for seaplanes and preliminary flying boat training, one for scouts and one for deck-landing and fleet co-operation. With each of these officers

were a number of Japanese officers acting as assistant instructors, together with pupils and the necessary personnel. All pilots who were accepted, *i.e.*, those who had passed the special medical examination, were posted to the Avro Flight where they had to graduate in the Gosport system. After successfully passing this preliminary course they would follow either of the undermentioned routines, depending on the suitability of the individual pupil, the exigence of the Service and his desires, as far as possible.

Scouts.
Panther ship aeroplane.
Fleet training course.
Turret flying and deck-landing.
Torpedo dropping, etc., from Cuckoo and Swift torpedo planes.

Seaplanes and/or preliminary training flying boats.
F5 flying boats. Long cruise round a portion of Japanese Islands (1,500 to 2,000 miles).
Fleet training course.



Damaged Sparrowhawk with metal propeller, one blade of which must be scrapped.

Special flying courses for observer, gunnery, photographic and W.T. officers were organised in the flights concerned.

All pilots had to undergo concurrently with the above suitable courses of technical instruction in aircraft, engines, armament, photography, navigation and wireless telegraphy. Night flying using Holt flares or the Lucas-Cranwell electrical sets was practised. The Fleet courses were very comprehensive, being carried out at Yokosuka, the nearest naval base.

An Experimental Flight, for dealing with new types, did in a small way such work as would be done at Martlesham Heath. There is a speed course, electrically timed and with *camera obscura*.

All instructions given during flying were in English, the terms used being absolutely unified and very simple in order that there could be no possibility of confusion.

The general conclusion reached as to the ability of the Japanese as pilots is that there is little difference in the time taken to pass successfully through the Gosport course of preliminary flying training, particularly when allowance is made for the fact that most of the pilots under instruction had at the commencement an imperfect knowledge of English, thus making the important conversations on the ground with their instructors, and lectures not so readily understood as one would wish. They show little, if any, signs of nerves and are always ready to attempt the most difficult manœuvres.

Armament. The Range, which is used from either side, for ground training. The Armoury, Bomb and Detonator Stores can also be seen.

Mechanical contrivances in general have, of course, only been known in Japan in recent years and this fact may no doubt account for the little interest shown by the average pilot in such devices being kept at the highest pitch. There is not, for example, the same keenness as exhibited by the youth of this country to possess a motor bicycle and keep it in the highest possible state of perfection. Such mechanical sense will undoubtedly develop, and in fact during the years we have worked with the Japanese and insisted on this point a noticeable improvement has been made. The general average of ability in pilots is distinctly high, possibly higher than we are accustomed to find in this country, but it would seem likely that there is a smaller percentage of abnormally good pilots. Due no doubt to the fact that the ancient cult of Bushido, education and tradition have tended to produce a racial and not an individual type, we may expect to find,

and in fact do find, a certain indecisiveness when they are thrown into a situation entirely unexpected, not to say dangerous. They do not seem to possess to the most desirable extent that instinctive sense of prompt action so essential under such circumstances, although if given time they would no doubt extricate themselves successfully.

They have the virtue of courage developed to the fullest extent and would go to any length to carry out orders, no matter what the odds were. They also have great powers of endurance.

Technical training has done much to encourage pilots to take a real interest in their machines and engines and every endeavour is made to foster healthy competition between respective units. The Japanese are often oblivious to disquieting noises in an engine, but training and practical experience have already tended to develop a keener mechanical sense of hearing.

The smaller stature of the Japanese is an advantage in many ways, but a disadvantage to them when suddenly called upon to fly a British machine; a number of minor alterations to controls, seats, etc., were required.

The mechanics are deserving of the highest praise, being extremely keen to learn and very hard working and have great *esprit de corps*.

A number of long distance flights over the sea were undertaken in addition to the ordinary cross-country flights. These were generally on the F5, it being the policy to finish each F5 course by a cruise round the shores of Japan. The total distance was generally over 1,500 miles, divided up into suitable stages, the longest being generally 450-500 miles. Longer flights have been carried out lasting over nine hours.

At our Central Training Station it is not uncommon to see forty machines in the air at once, which will give some idea of the activity prevailing.

The efficiency of an Air Service may be judged with some accuracy by the accidents ratio, *i.e.*, the ratio of fatal accidents to hours flown. Careful records were kept from the commencement and the following statistics were produced in a similar manner to those for the Royal Air Force:—

I.J.N. Air Station, Kasumigaura.

Training Period.	Flying Hours.	Ratio Killed per 1000 hours.
June to December, 1921	983	0
January to December, 1922 ...	3,335	.59
January to October, 1923	7,278	.41

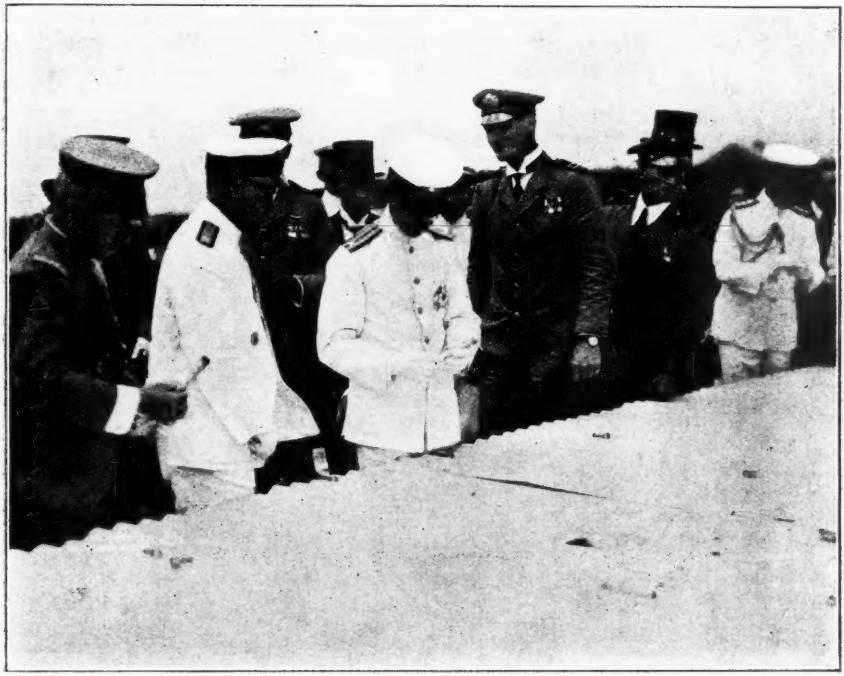
All I.J.N. Air Stations.

Training Period.	Flying Hours.	Ratio Killed per 1000 hours.
January to December, 1921 ...	2,798	.714
January to December, 1922 ...	4,987	.802
January to October, 1923	10,090	.495

Practically all casualties were due to error of judgment of a common nature. No fires in the air or after crashing occurred. No machine failed in the air from defective structure.

I think one accident to an F5, involving the death of two, is so extraordinary as to be worth relating. An F5 on a long cruise encountered very bad weather and endeavour was made to reach the destination by making a short cut across a narrow peninsula, thus saving a considerable amount of time. The sea was too rough to land on safely and the pilot knew that there was a shallow lake in

the middle of the peninsula on which he could land if found desirable. After flying over the land for a short period the weather became infinitely worse and very thick. The pilot decided to land on the lake and instructed the officer in the front cockpit to keep a close look-out for it, which he did, standing up and peering over the side. At times the machine, in which were seven officers and men, was almost out of control. Without warning a terrific down bump was experienced, which threw the observer out of the cockpit into the starboard propeller, which cut his head in half; at the same time another officer was thrown out on to the upper plane, outside of the radius of the port propeller, whence he clung to the aileron balance wire greatly amazed but unhurt. This bump put the machine temporarily out of control and before such could be regained she hit the water and broke her back, killing the wireless telegraphy operator and



Inspection by H.I.H. the Prince Regent. Demonstration of B.I.B. bombs.

injuring the pilot and observer. The pilot, a Japanese officer, had previously been on a long cruise with the B.A.M. officer in charge of the F boat instruction. At the time he was in charge of three F5 boats on a similar instructional cruise. Under the remarkable circumstances his presence of mind was deserving of the highest praise.

Technical Section

The Technical Section was composed of five officers, one in charge of section, one for aircraft, one for engines, one designer and lecturer on aeronautical engineering, and one for technical training and also parachute training. As indicated previously, there were also five warrant officer engineers, four riggers and one

draughtsman attached to this section. A warrant officer would be attached to one or more flights, workshops, etc., to instruct and generally supervise the work. Engineer officers and ratings were continuously under instruction in the flights and workshops, but this procedure was a temporary measure pending the formation of the School of Technical Training, which includes fully equipped shops for the purpose of giving instruction in every branch. At the commencement, of course, there were no facilities at all for the overhauling and repair of engines and aircraft, but such were gradually built up so that within a period of less than two years the repair shops, which were absolutely self-contained, had a capacity of completely overhauling sixteen rotary and eight stationary engines of the "Viper" type, or alternatively to this latter two "Eagle VIII.'s" and one "Lion" per week.

General view of the Air Station after one and a half year's work. The Seaplane Station is on the extreme right.

The capacity of the Aeroplane Repair Shop would be about six completely rebuilt machines a week. These facilities are to be considerably extended.

The Engine Repair Shop and Machine Shop are situated in the centre of the flight hangars, which are in the middle of the aerodrome. The Machine Shop has the most complete equipment of lathes, milling, shaping, gear cutting and grinding machines, etc. Adjoining this is the Engine Repair Shop with two small completely equipped shops for the repair of magnetos and carburettors. There is a foundry capable of handling castings up to five cwt., and blacksmiths, coppersmiths, tinsmiths and sheet metal workers' shops, fully equipped with welding, case-hardening and other essential equipment. Stores for raw material, complete engines, engine spares and tools were conveniently situated. Test benches for

handling engines of any type up to 1,000 h.p. and fully equipped are close to hand.

Many of the machine tools are of Japanese manufacture and in most cases very well made, although in some instances material of an unsuitable specification has been used. A well equipped laboratory for the testing of all materials was organised.

The Aircraft Repair Shop was equally complete with wood store, wood-working, propeller building and repair, dope and fabric shops and all the necessary stores.

The engineer officers are all extremely keen, but were almost without exception far too immersed in theory, being content to leave all practical matters involved in the running of an air station to their petty officers and men. It was not previously considered necessary that they should be practical men thoroughly versed in the maintenance and repair of aircraft material. They worked long hours and with great concentration, but immersed in theory. To change this took time, but practical example had its effect and from top to bottom the fundamental necessity of a very thorough practical training is now recognised. Theory in this case must be secondary. Those who have not got the direct responsibility of keeping Service equipment in an efficient state can undertake research.

The men are splendid, keen and hard working and the doctrine of "a limitation of output" does not exist. They will often forego leave without being asked in order to finish some work on hand. They make with training excellent machinists and mechanics. Blacksmiths are remarkably good but have, as in other cases, not so good a knowledge of the properties and treatment of material as might be desired. Realising that the Japanese have been famous as sword makers for at least a thousand years, the products being acclaimed by occidental authorities as the equal if not the superior of those of Damascus and Toledo, this seems strange. In other directions the remarkably economical use of material shows a practical knowledge of its physical properties.

Aircraft

The machines used are in most cases so well known here that detailed comments are unnecessary. Troubles were experienced with the damp, but were not serious. Every variety of climate is to be met with and all-metal aircraft will possess very definite advantages. The various systems of this form of construction are now receiving close attention.

All machines gave results quite up to if not above the average. The "Sparrowhawk" fulfilled all expectations and proved the most successful scout training machine so far met with, and if fitted, as planned, with a radial engine ("Lynx" or "Jaguar") would be even better.

F5's were kept moored out, only being brought ashore periodically. The policy of man-handling such machines should, it is thought, be reduced to a minimum and the old time method of putting machines in sheds each night rendered needless by the improvement of weathering qualities.

No structural failures occurred in the air nor fires as the result of a crash.

Interesting tests under service conditions, and in some cases from the aircraft carrier "Hosho" were carried out with the Blackburn "Swift" torpedo carrier, which is similar to the "Dart," the standard Air Force type; the supermarine "Seal" amphibian flying boat, similar to the "Seagull" (which is an improved "Seal"), the standard type used in the Royal Air Force aircraft carriers, and the Vickers' "Viking" amphibian flying boat, the forerunner of the "Vulture" now attempting the world flight.

Engines

All types are so well known here as to need no comment. Failures were very few and mostly confined to the Le Rhone, an engine very sensitive on the fine adjustment and with single ignition. Running times before complete or partial overhaul were well up to the average standard. It was found desirable to lower the compression ratio of the "Lion" from 8 to 1 to 5 to 1, as the machines into which this type are fitted operate in general at a low altitude.

During the winter months it is sometimes necessary to attach special spinners to the propellers of the rotary engines to prevent over-cooling. Before taking this precaution engines had failed, due to the complete blocking of the crankshaft with ice.

General view of the I.J.N. Air Station, Kasumigaura, after two and a half years.

Aircraft Carriers

The Japanese Navy have the distinction of being the first navy in the world to lay down an aircraft carrier.

In December, 1920, the "Hosho" was laid down at the Asano shipyard, near Tokyo. She is a vessel of 9,500 tons with a speed of 25 knots. Her length is 510 feet, beam 62 feet. Her first sea trials took place in March, 1923.

Prior to the earthquake two battle-cruisers, which had been scrapped by the Washington Conference, were to be converted to aircraft carriers of something like 25,000 tons each. One, the "Amagi," was however so damaged at the Yokusuka Dockyard by the effects of the earthquake as to necessitate scrapping. The "Akagi" is being proceeded with. The battleship "Kaga," also due for

scrapping under the Washington Treaty, is probably to be modified and converted into a carrier. The accompanying slides show the flying deck of the "Hosho." As yet deck-landing is in its infancy, having been practised so far by a selected number of skilled pilots.

There is also a small seaplane carrier, the "Wakamiya," which was put into commission some years ago.

Timbers

Indigenous Japanese timbers have not received the study they deserve from the point of view of their suitability for aircraft purposes. Most of the timbers used in Japan, such as spruce and ash, are imported from this country, America and France.

There are of forest trees alone nearly 290 species divided among about 70 genera. A vast quantity when we consider that Europe has some 70 species divided among about 35 genera.

"Hinoki" may be used as a substitute for spruce, and is equal to grade "A" except in the value of "E." This slight defect would really only affect long struts, entailing in that case a small increase in weight. White Hinoki (Cupressus obtusa) is superior to the red variety.

There are several timbers which might be considered as substitutes for grade "B" spruce, and it is quite possible, should circumstances dictate, that such may with careful selection be equal to grade "A" Korean Pine, Formosa Pine, Manchurian Pine, and Katsura.

Kiri (Paulownia Imperialis) is suitable for use in non-structural members.

Kurumi (Juglans manchurica), which is Japanese walnut and was used here during the war, is suitable for propellers. Shii (Pasania cuspidata), pointed pasania, is a wood which may have desirable qualities for a similar purpose.

Keyaki or ash (Planera japonica) is the best of all woods of this nature. There are others such as Oba shira kaba (White birch), Nara (Quercus glandulifera), which are worth further investigation.

For mahogany there appear to be no direct equivalents.

The soft woods seem superior to European or American in so far as they are affected by expansion and contraction due to moisture changes. Japanese timbers generally are remarkably resistant to rotting, splitting or decay, even when exposed to the full forces of nature for years, although quite unprotected by paints, varnish, or such like.

Propellers

Wooden propellers, as might be expected, give a good deal of trouble in Japan, particularly in the summer. All the wooden propellers we had in use were manufactured in this country. There is good reason to believe that those manufactured in Japan, particularly from suitable indigenous timbers, would be superior.

A number of steel propellers of the Leitner-Watts variety were tried on each type of engine. Some of these were two and others three-bladers. Many have been running for a considerable time and no failures have occurred. There can be no doubt that the metal propeller will come more and more into general use, as its advantages, particularly in the tropics and for seaplanes, transport as spares, etc., are very large. On our principal aerodrome, which is of large area, the grass and vegetation generally grows with such remarkable rapidity in the spring and early summer that it is almost impossible to cut the whole area rapidly enough. Under these conditions the anxious pupil embarking on his first solo and being told to keep his tail well up does so with such effect that the grass

gets cut by the propeller, with results which are disastrous after an average morning's flying. The wastage of wooden propellers was under these circumstances extraordinarily high. Steel propellers, of course, never suffered and could cut grass with impunity. At the time these propellers were ordered, in the commencement of 1921, they were the only type of metal propeller being manufactured in the world. Since that day minor improvements in design and methods of manufacture have led to the production of a superior product, particularly as far as interchangeability of blades and weight-saving are concerned. It is, I think, well known that propellers for horse-powers of under five hundred are heavier if made of steel, but above this the reverse applies.

In the examination of the accompanying slide one of the advantages of the metal propeller is seen. The machine in question overran a light railway which was being used in the construction of the aerodrome, with the result that the undercarriage collapsed and one blade of the propeller came into contact with the ground. The other blade was undamaged, as also was the hub. The machine was put into commission again, a spare blade being fitted to replace the one damaged.

Dope

It was realised from the commencement that the Japanese climatic conditions would be peculiarly trying to doped surfaces on account of the great dampness in the summer months and also on account of the strong sunlight. For these reasons it was decided to use a pigmented nitro-cellulose dope which had been developed by the Royal Aircraft Establishment, known as P.D.N. 12. Aluminium nitro covering V 84 was used in addition. This doping scheme was largely employed and three coats of dope, plus two coats of the nitro covering, proved entirely effective, and when comparing with machines doped with other preparations of a cellulose acetate basis it never failed to show to extreme advantage. The well-known defect of the slackening off of fabric doped with a cellulose acetate preparation was most marked under the humid conditions prevailing, particularly in the early mornings in the summer months, although under such conditions no change occurred when nitro dopes were used. Many weathering tests were made and gave valuable data. In the case of two samples exposed for many months the following results were noticed (see slides):—

PROPRIETARY DOPING SCHEME SPECIALLY RECOMMENDED FOR TROPICAL COUNTRIES (ACETATE BASE).

Part.
Aileron from Avro.

Exposed.
New.

Date Exposed.
22/2/22.

Examined.
29/5/22. Aluminium varnish cracking.
24/6/22. Varnish coming off, dope film cracking.
20/10/22. Fabric exposed in parts, dope flaking off. Photo taken (see slide).

Total Time Exposed.
Eight months.

P.D.N. 12 PLUS V 84 SCHEME (NITRO BASE).

Part.
Aileron from "Sparrowhawk."

Exposed.
After completing 40 hours on machine two months in service.

Date Exposed.
25/1/22.

Examined.
29/5/22. Condition perfect, no change.
24/6/22. No change.
20/10/22. No change. Photo taken (see slide).

Total Time Exposed.
Nine months.

A number of test frames treated with clear and pigmented acetyl or nitro dopes and nitro coverings were exposed to the weather for 11 months. Tautness was measured before and after weathering, firstly when in a dry atmosphere and secondly when in a moist. The P.D.N. 12 V 84 combination proved superior to all others. The following comparisons form interesting data of the results obtained with two of the test frames:—

TAUTNESS BY "DEPRESSION" METHOD.

Depression in mm. by 400 gram. weight.

Description.	Time exposed to moist atmosphere 88 R.H.							
	"Dry."	1.	2.	4.	6.	7.	24 hrs.	
UNWEATHERED.								
Pigmented Nitro Dope P.D.N. 12 (1.9 ozs. sq. yd.) + Aluminium Nitro covering V 84 (0.6 ozs.)	2.5	2.9	3.1	3.4	3.6	3.6	3.6	
WEATHERED (11 months)...	3.3	4.3	4.4	4.9	4.6	4.4	4.3	(45% R.H.)
UNWEATHERED.								
Clear Acetyl Dope A.D. (1.2 ozs.) + Khaki Aluminium Nitro covering P.C. 10 (0.8 ozs.) + V 84 (0.6 ozs.)	3.0	3.6	4.3	5.0	5.6	5.6	5.6	
WEATHERED (11 months)...	4.0	5.3	5.9	6.1	6.1	6.0	6.0	(95% R.H.)

The fallacious arguments so often voiced as to the added fire risk in connection with nitro-doped surfaces have been fully dealt with in a recent paper before the Society, and therefore need no comments here.

The Japanese make excellent fabric workers. A certain amount of dope, in some cases to B.E.S.A. specifications, is being manufactured in Japan, as also fabric of various grades.

The dopes and varnishes generally give an uneven film due to the difference in the volatility of the solvents, which suggests that the manufacturers have not paid sufficient attention to their proper blending. The use of "ether alcohol" as a solvent produces to a marked extent in the finished product the undesirable tendency to dry white in a moist atmosphere.

Lacquer and Anti-fouling Compositions

One can hardly refer to Japan without mentioning lacquer, with which a certain number of interesting tests were carried out. This medium, which requires peculiar conditions and great skill in its application, proved useful for the treatment of steel undercarriage struts, interplane struts and wires. It is, however, inclined to be somewhat heavy, and it has a tendency to chip.

It was hoped that good results might have been obtained in the protection of propellers, where the lacquer was applied direct to the wood, but such has not been as satisfactory as was anticipated; but it is possible that a combination of fabric and lacquer might be more so, as such is generally applied in this manner.

Experiments are to be carried out with a view to determining its anti-fouling properties when applied to the hulls of flying boats.

Lacquer, the sap of the "Rhus Vernicifera," may cause poisoning in any state except the dry. This point has been much exaggerated over here, and although the effects may be painful, causing itchings and swellings, there is no danger.

Some twenty proprietary and specially made up anti-fouling compounds, painted on wooden stakes, have been under test during the last two years. The samples are now being returned for detailed examination, and it is as yet too early to arrive at any definite conclusions.

Aviation Spirit

The oil wells in Japan are not very prolific, and unfortunately the aviation spirit produced has a low aromatic content, roughly about four per cent., which would make it equivalent to American spirit. The best is known as Aoi Komori, which has an average Baume gravity of 72 degrees, initial boiling point 35 degrees, final boiling point 124 degrees, distillation up to 100 degrees, centigrade 93 per cent. It is considered that the supply of this aviation spirit, which is very light and free from constituents of high boiling point, cannot keep pace for much longer with the present demands, and for this and other reasons aviation spirit which will pass B.E.S.A. specification is being imported from Sumatra and Borneo from the Asiatic Petroleum Co.

Benzol is obtainable, but did not always prove to have been sufficiently scrubbed, *i.e.*, free from sulphur.

Oils

Castor oil is manufactured from Japanese beans, and also a certain quantity is imported from America; this latter is being used for aviation purposes, but is not up to B.E.S.A. specification.

Mineral oils of Japanese origin can be obtained, but no composite oil, such as is required for aero engines, supplies of such oils being imported from this country.

Parachutes

Two types are used as standard—the Guardian Angel D.4 and the Mears.

The Mears is particularly useful for fitting on machines where it is difficult to stow the D.4. It does not, however, function satisfactorily in still air and is not consequently suitable for dropping from kite balloons. All these parachutes were made of cotton, but in future orders will be made of silk on account of the smaller bulk and superior glissading qualities of this material.

Other parachutes were experimented with and valuable data obtained, but no change in the policy of standard types was called for.

Several parachute courses were held with a view to training personnel in the operation of parachutes, but it is not proposed to make a descent by every flying pupil obligatory. The courses started by jumping from a kite balloon preceded by "dummy" drops to give the pupils confidence. Instruction was given in the delicate operation of folding, particularly in the case of the D.4. The course finished by jumping from an aeroplane, and lasted about three weeks in all. One may say that the courage shown by all pupils faced with the disagreeable necessity of throwing themselves into space was remarkable.

It was considered necessary to examine the parachutes twice annually—in May and October—but as an additional precaution when demonstration drops were made at the commencement of the summer, the weather then being very damp, to examine and refold immediately prior to use. It is considered that parachutes will eventually be deemed indispensable safety devices, but that era has hardly yet dawned.

A series of fifty drops with 150 lb. dummy weights were carried out with the Mears parachute from between four and five hundred feet, and in some cases as low as two hundred feet. The average time taken for the parachute to open was

1½ seconds. In one instance the unrolling strip was purposely not attached to the aeroplane and the parachute was allowed to fall without unrolling from a height of 600 feet. After falling some 400 to 450 feet it emerged from its case and functioned quite normally. The reliability of the Mears which had been in dispute was amply proved.

A good deal of demonstrating was done with parachutes, which were seen in Japan for practically the first time.

Armament Section

The Armament Section consisted of one officer in charge and one assistant, together with a number of Japanese officers and men, none of whom had previously had much, if any, up-to-date experience in this particular branch. A good deal of difficulty was experienced in the first instance in collecting the necessary gear in this country, which somewhat hampered progress in Japan. Special attention was given to the training of armament officers, and at the same time necessary instruction had to be given to pilots and observers. Both officers and men showed themselves to be very adaptable and were extremely keen.

The material in use was thoroughly up to date, and generally speaking in line with that used in this country. Vickers and Lewis guns are, at the moment, used as standard. There are bombs up to 500 lbs., and, of course, others in contemplation. Torpedoes are very similar to our own and are manufactured in Japan.

The most complete facilities were available for instruction. On the range, instruction (Vickers and Lewis) could be given on the ground or in the rocking fuselage, or in fuselages with engines, as for instance in the case of observers.

Bomb-dropping at the Central Training Station has been mainly confined to the dropping of practice bombs filled with stannic chloride at targets moored on the lagoon. This, of course, is in addition to practice with the Batchelor Mirror, which was sometimes placed in a seaplane tender. Practices with camera guns followed by Lewis and Vickers for both pilots and observers are carried out over the lagoon at suitable targets.

Preliminary practice in torpedo-dropping with dummy torpedoes is carried out over the lagoon. For live bomb-dropping and advanced torpedo work a special station is in course of equipment in the South of Japan, where conditions are particularly suitable for carrying out such exercises.

It is unnecessary to go into such matters in further detail as they are well known over here, and a few slides will serve to illustrate the lay-out of the armament buildings.

Photography

The Photographic Staff consisted of an officer and a warrant officer, both of whom had been photographers by profession before joining our own Air Service at the commencement of hostilities, where they gained a vast amount of air experience.

Japanese as a whole are inordinately good on photography, so this at least was a good atmosphere to start with.

From the commencement, photographic records were kept of the progress of work, and considerable benefit was derived from mosaics in considering the lay-out of the whole station.

The training of specialised photographic officers was undertaken, and also special courses for pilots and observers. For air work two types of cameras were in general use—for obliques the type 18 was used, and for vertical work the L.B.2. Both of these cameras, as might be expected, proved very successful.

Special machines were kept solely for the training of the photographic personnel.

In taking photographic stores to Japan a good deal of discretion was called for, and materials, of course, required very careful packing to ensure their safe transit through the tropics. For this reason, and also that the climatic conditions in that part of Japan to which we were bound were somewhat unknown, it was considered prudent to limit the amount of material taken out in the first instance to sufficient for immediate requirements.

Many complications foreign to us in this country arise, due to the heat and humidity experienced, particularly in the early summer months, entailing the use of special cooling tanks and hardening agents. Plates, films, papers, etc., must be kept in airtight cases.

The best conditions for aerial photography are met with in the autumn, winter and spring, the worst being experienced in the months of June, July, August and September, due to the humid—very often over 90 per cent.—and consequently misty atmosphere prevailing during the summer, in which period not much more than 10 per cent. of the days are suitable for practice; this would be less but for the use of special plates and filters.

A certain amount of photographic material is manufactured in Japan, but the cameras used for ground work proved in general too flimsy in construction. Suitable plates are not manufactured at present, nor is the paper available quite up to the standard required, although great improvements have been made in the last two years. The cinematograph is widely used for instructional purposes, and suitable films are being and have been made for circulation to all naval air stations.

Medical Section

The medical side has in some measure been touched upon when reference was made to the psychology of Japanese pilots. The medical officer had made a special study of aerotherapeutics.

All pilots are, before acceptance, subjected to an examination similar to that in force here, which, as you know, includes a number of special tests. Experience has shown no need for any modification of the standard to which we are accustomed. In the first batch of fifty candidates only one was rejected, and that was solely due to slightly defective vision. The average age was twenty-five—somewhat higher than the ideal.

It is not desired to enumerate all the details and results of these tests, but it may be remarked that those applied to the respiratory system showed results above the normal. Exaggerated reflexes are very exceptional. The balancing tests are nearly always perfect; vision good; colour vision normal; the capacity to maintain an even ocular muscular balance under increasing disability (Bishop Harman Test) is below our normal standard.

In view of the strong sunlight, all goggles were fitted with Crooks anti-glare lenses, three intensities being available. No cases of glare and retinal fatigue occurred due to this precaution.

Games are widely played during the summer but not so much in the winter, although their popularity in the colder months is increasing. Great stress was laid on the necessity for the encouragement of this form of recreation, and many games were introduced.

Measurement of Progress

Standards applying to all sections were laid down, it being found necessary that those under instruction should pass such standards as were considered desirable, depending on the particular duties for which they were being trained.

For instance, under the heading of Flying, Standard "A," dealing with preliminary flying training, calls for the undertaking of eleven definite tests, most of which have to be carried out in the air to the satisfaction of the instructor.

Technical Standard "A" (Aeronautical Engineering) for Engineer Officers deals with the testing and use of all materials in aircraft construction, the testing of aircraft performances, etc.; this necessitates a written examination.

Again, Armament Standard "F," dealing with torpedoes, necessitates examinations both oral and written, and in addition the accomplishment of certain tests, and the dropping, firstly of dummy and secondly of live torpedoes.

Photographic Standard "B" lays down tests and examinations to be passed by pilots.

The method of marking was as follows:—For all standards there was a possible 100 marks in each case. Any pupil obtaining less than 75 marks would be rejected, but he might be given an opportunity of being re-examined at a later date. Those obtaining between 75 and 89 marks were granted a Second Class Certificate and those obtaining 90 marks and over were granted a First Class Certificate.

This system was found to work very well and to foster a healthy spirit of competition. The benefits of such a system in the keeping of accurate records may be well appreciated.

It is probable that a technical examinations board may be set up for the examination of ratings (not necessarily compulsory) with a view to giving preference, when promotions are being considered, to those whose technical progress has been most marked.

Aeronautical Research in Japan

The Committee for Aeronautical Research was first established in April, 1916, in the Imperial University in Tokyo. This Committee's first task was to make plans for the building of an Aeronautical Institute, which was duly completed and commenced work in August, 1919, but very unfortunately was almost entirely destroyed by the recent earthquake and the resultant fire.

The Director, Professors and Assistant Professors are appointed by the Minister of Education, and funds for research are provided by the same authority. The Director of the Aeronautical Institute is under the control of the Principal of the University of Tokyo.

The work of the Institute is carried on under twelve sections:—Physics, Chemistry, Metallurgy, Materials, Aerodynamics, Engines, Aircraft, Instruments, Psychology, etc. The general nature of the research done was similar, although, of course, on a smaller scale, to that carried out at the National Physical Laboratory. Research is also carried out at the Naval Air Service Laboratory, Tokyo, and at a similar organisation for the Military Air Service at Tokorazawa. At this latter place remains the only complete wind tunnel in Japan to-day, as the one at the Aeronautical Institute and the other at the Naval Air Service Laboratory were destroyed with both these establishments during the recent earthquake. All wind tunnels were of the Eiffel type, but there is every reason to believe that an N.P.L. type wind tunnel will be erected in the near future.

It may be mentioned that the one William Froude tank belonging to the Navy was destroyed, the only remaining tank belonging to the Mitsubishi Company.

It will be seen from the above that there is at present little research co-ordination, each Service carrying out its investigations, with consequent overlapping. In certain cases, however, researches of a more general nature have been carried out and the result made public.

It is probably not realised here what a very severe handicap the Japanese language imposes on the research workers, who have to become proficient in at least two or more European languages before they can commence work at all. Accustomed as we are to thinking and calculating in our own language in whatever work we may be engaged in, it seems difficult to realise the possibility of making progress under the disadvantages to which the Japanese are subjected. Research reports are generally published in English, French or German, but there is a movement afoot, fostered by a prominent Japanese scientist well known in aeronautical research, for the use of Romaji, *i.e.*, a Roman character being used instead of ideographs. The spoken language remains the same; the written, however, is very materially simplified.

The value of research work is very fully realised, and it is likely that Japan may be ahead of most other countries in appreciating this fact and in giving scientists direct representation on all important State bodies.

In view of all the circumstances the progress of research work is remarkable, and has attracted a large number of the foremost Japanese professors, many of whom are exclusively engaged on aeronautical research. Its appeal to students in addition is considerable. In the Aeronautical Institute, naval and military and other students are continuously undergoing special training. Latterly, the Naval Air Service Laboratory has been largely devoted to instruction.

Very valuable aeronautical researches are being undertaken at Sendai University, some few hundred miles north of Tokyo. Similar work has been going on in this direction for the last ten years and has received world-wide attention and appreciation. Original research work has recently been carried out in relation to the electro-magnetic properties of iron and steel alloys. High tensile steels and light alloys are, of course, receiving considerable attention in particular reference to their possible uses in aircraft construction.

At the Central Naval Air Training Station detailed plans have been got out for the building of a fully-equipped full-scale aircraft testing section both for aeroplanes and seaplanes. This would be working in conjunction with a fully-equipped aircraft experimental factory for the production of highly-specialised Service types, not in quantity but merely for experimental purposes. A speed course, which has already been referred to, has been in operation for some time.

Aircraft and Aero Engine Manufacturers in Japan

There are five companies, prominent amongst them being the Mitsubishi Company and the Kawasaki Dockyard Company Ltd., manufacturing aeroplanes, seaplanes, or flying boats. These firms generally manufacture either for the Naval or Military Air Services, but not as a rule for both. In addition to this source of supply a certain number of aircraft are built in the Naval Dockyards and military arsenals.

The machines being manufactured in Japan at the moment are:—The Avro 504 K., 504 L., the F.5, Salmson, Nieuport, and several types of Mitsubishi machines, such as the single-seater fighter, two-seater reconnaissance machine, and the two-seater torpedo carrier. Two machines—the Yokosuka type seaplane and the Nakajima type—both of Japanese design, are also built, the latter in small quantity for commercial uses only.

Many British firms are represented, but only two have undertaken—in one case directly and the other indirectly—construction work, although negotiations are on foot which may add to this number. The two mentioned are Messrs. Short Bros., who built a number of F.5's in Japan, and the Sopwith Aviation Company, or rather the technical staff of the late Company, employed by the Mitsubishi Aircraft Company. In the former case instruction was given to the personnel of the Naval Aircraft Factory in Yokusuka Dockyard in the construction of the F.5.

A number of this type have been produced. Assistance has also been given to a company now constructing F.5's for the Naval Air Service. In the latter case, designs were produced to fill the specifications of the Naval Air Supply Section, and when accepted such machines were built under instruction. The single-seater fighter and two-seater reconnaissance machine have been in production for some time. The pioneer work done has been of the utmost value, and it is no exaggeration to say that the above-mentioned concerns have been responsible for laying the foundations of the Japanese aircraft industry on lines which by years of experience and independent world-wide testimony have been proved to be unsurpassed.

Two firms are manufacturing aero engines—the 300 h.p. Hispano Suiza (French type) and the Le Rhone. The Navy used to manufacture a few Benz type engines for training seaplanes, and the Army are manufacturing the Salmson. The question of building further engines under licence is receiving immediate consideration.

There are some half-dozen firms manufacturing various grades of fabric, dope, A.G.S. parts, etc.

The good all-round quality of machines being built for the Naval Air Service under a system of careful inspection has been referred to before.

The machines of French design for the Army Air Service are constructed in accordance with the practice prevalent in that country.

The production of the Hispano engine is very creditable, as it is a difficult engine to build and the first engine constructed by the Mitsubishi Company. It in no way discredits its French parent.

The Education of Public Opinion

An enlightened policy of educating the people as to the value of the country's defences is pursued. Naval air stations are open one day a week to visitors. Every town or village in the neighbourhood sends on the day arranged its quota of school children, students, parents and even grandparents, special trains being arranged if required. The people being naturally orderly and obedient to authority are easily handled by a few sailors. They do not write on the planes or sit on the elevators; oddments such as watches, magnetos, sparking plugs, etc., renowned over here for their special powers of disappearing on these occasions, have no such habits in the Land of the Rising Sun!

Flying-off practices from the cruiser specially detailed are nearly always viewed by a limited number of spectators.

Lectures are given throughout the country on flying by officers specially detailed.

Conclusion

I have endeavoured to give you a picture of aviation in Japan, more particularly applied to the Navy, but it has been impossible to go into the many questions involved in any detail, and in fact certain aspects have not been touched on at all, as for example the great interest created by our work, which was inspected by H.I.H. the Prince Regent, H.E. the British Ambassador, and practically all the Japanese naval, military and civil officials of importance. The aerial escorts required on the occasion of the return of the Prince Regent from his visit to Europe and of the Prince of Wales' visit to Japan were organised and led by the British Aviation Mission. On the latter occasion there were some four formations comprising nearly twenty machines, the "Renown" being picked up some two hours' steaming from Yokohama.

I must apologise for going over much ground very familiar to the members of the Aeronautical Society, as also for the fact that the lecture has not been so highly technical as those to which they are usually accustomed. It will, however, I think, be conceded, that the great pressure of organising and training largely precluded intensive full-scale research. I might also add that the earthquake has rendered the collection of additional information almost impossible, more important matters intervening.

The policy to be adopted when friendly powers ask for assistance in the formation or reformation of their air services has been much discussed, but no definite plan seems to have been followed; in fact, violent extremes are found. I venture to submit that had those in authority here in the past been more sympathetic, the sphere of British influence in aeronautical matters could have been vastly extended. Our aircraft and equipment generally continue to prove their superior qualities, the technique of flying is more highly developed here than elsewhere, and our methods of construction ensure the maximum of safety and durability, and it is for these and other reasons that foreign powers turn to us. Should they not, therefore, be welcomed and assisted officially to a reasonable extent otherwise, they will very naturally seek the aid of other countries more sympathetic to their needs, as has often been the case in the past.

The sincere appreciation shown of our efforts was at all times most encouraging. H.I.M. the Emperor honoured each member of the Mission by conferring a decoration. The courtesy and kindness of the Admiralty, and in fact of everyone, is beyond description, and adds considerably to our indebtedness.

The very complete powers given by the Japanese Admiralty, who did all they could to comply with our smallest suggestion, and the hard work and loyal co-operation of my staff, went further than anything in bringing our undertaking to, may I say, a successful conclusion.

I must express my sincere appreciation for such assistance as has been rendered by the Air Ministry from the commencement. My thanks are especially due to the Air Member for Supply and Research for permission to make use of certain results obtained from materials which have been under test in Japan.

I have also to thank the Japanese Admiralty, naval officers on the Staff, Japanese scientists, and many others for their valuable help.

Discussion

The Chairman said he did not think anyone could have any doubt, after hearing this admirable lecture, and having seen so many interesting pictures, that the Japanese Admiralty had done well to choose Colonel the Master of Sempill as the head of the British Aviation Mission. The whole of the organisation and lay-out of the work must have struck everyone as being very remarkable. The Paper, however, did not lend itself to discussion in the ordinary way. There were several very distinguished people present whom he was sure everyone would like to hear, and he invited His Excellency the Japanese Ambassador to address the meeting.

His Excellency the Japanese Ambassador said that he was no expert on aeronautics, but he was quite sure that they had all listened to a very interesting and able paper. The Japanese Government had been very fortunate in securing the sympathy of the British Government in connection with the development of its Naval Air Service, and was greatly in the debt of the Mission, and particularly of the Lecturer, who had commanded the Mission. It was well known that Japan owed its Navy and its Merchant Marine to this country, and he was sure that the assistance afforded by Great Britain in connection with aeronautics was something to be remembered, not only by his Government, but by his people. The mission

had been the medium through which the friendship existing between the two countries had been cemented even more closely than was the case previously. He did not think he was capable of saying anything on the technical side of the Paper, but there was one thing he did remember, namely, that when the Lecturer returned to this country he had promised to take him (His Excellency) for a trip in an aeroplane, but he had not done so (laughter). He looked forward to the time when it would be possible for Colonel the Master of Sempill to take him over to Tokio in the space of four or five days.

Major-General Sir SEFTON BRANCKER, K.C.B., A.F.C., considered that the Japanese Government were to be congratulated heartily upon their enterprise in putting this expedition through. He himself was not at the Air Ministry at the time, but he remembered that when they came here and started these negotiations they were received with the customary chilliness of a Government department, and were not given very much help until they discovered Colonel the Master of Sempill, and then everything went right. They were bent on getting Great Britain to help them in the air, and, with their usual determination and common sense, they got the scheme through. That was a compliment to us. They had come to us in the old days for help for their Navy; we had given it to them, and they had made very good use of our experience, and he was glad to hear from His Excellency that they had not been disappointed this time. But we ourselves had something to learn from Japan. He had had the good luck, in 1906, to go round the Manchurian battlefields with the Japanese Imperial General Staff, and had been enormously impressed; perhaps the chief reason why the Japanese had won that war was their tremendous patriotism, their *esprit de corps*, and their extraordinary loyalty to one another and to their cause. From what Colonel the Master of Sempill had said, that spirit is still burning bright in Japan. Like ourselves, the Japanese were a nation of seamen, and he thought it had been proved pretty conclusively that the qualities that made a good seaman were much the same as those which made a good airman. Therefore, we could promise Japan a great future in the air. We had to thank Colonel the Master of Sempill and his staff, not only for the lecture, but for their efficiency and thoroughness, which had resulted in placing British prestige very high in Japan and in strengthening our friendship with our old allies, which had lasted a very long time.

Commander TOYODA, Japanese Naval Attaché, said that he was very pleased to have the opportunity of expressing their thanks for the valuable assistance given to the Japanese Naval Air Service by the British Aviation Mission under Colonel Sempill. Japan had always appreciated the efficient and progressive methods of this country, as well as the quality and sound design of its manufactures. It was only natural, therefore, that the Japanese Government should come here when creating a Naval Air Service. The great strides which that Service has made in such a short space of time was ample proof of the hard work carried out by Colonel Sempill and his staff. Before the Mission came to Japan, flying was in its infancy, the number of serious accidents being fairly high; since then, however, the accident ratio had been reduced to a very low figure indeed.

In addition to the aviation work, there was another very important feature arising out of the visit of the Mission, namely, that it helped in further strengthening the friendship which had existed for so long between our two countries. On behalf of Japan, he would like to assure the audience that they desired nothing better than that firmest friendship and concord should exist between Great Britain and Japan.

Lieutenant-Colonel MERVYN O'GORMAN, C.B., associated himself entirely with the words which had fallen from Major-General Sir Sefton Brancker. They were an expression of precisely what he felt. The Japanese Government had been fortunate in getting Colonel Sempill, and Colonel Sempill had been fortunate in having that versatile, tremendously courageous and ingenious people to train in

the ways of the air. When he looked at Colonel Sempill he marvelled to think that, as Goldsmith had said, "So small a head should carry all he knows." (Laughter.) That, at the age of some 26 or 27 years, he should have been three years in Japan, ranking with the Japanese Admirals—than whom none were greater—was perfectly astounding. The Society had been very lucky in getting him to read a paper, which had been very interesting; and so far as he could speak for the members, they congratulated themselves upon it.

Lieutenant-Colonel F. G. PIGGOTT, Military Attaché to H.B.M. Embassy, Tokyo (*communicated*): Although not qualified to make any observations on the technical aspect of Colonel Sempill's lecture, which has dealt almost entirely with naval aviation in Japan, I should like to draw attention—in my capacity as Military Attaché at Tokyo—to Colonel Sempill's reference to the work of the Military Air Service in maintaining communication immediately after the great calamity last September. The conduct of this branch of the Imperial Army was typical of what the Japanese soldiers did for their country in those terrible autumn days; succouring the wounded, feeding the hungry, sheltering the homeless, transporting refugees, restoring and manning the telegraph and telephone services, relaying the tramways, repairing the roads, re-building bridges, repairing the railways, reinforcing the civil police, etc., etc. During the period of martial law all classes relied on the Army, and not in vain.

There is an important non-technical aspect of Colonel Sempill's lecture which should not be overlooked, namely, the effect of his mission on British prestige. In the little corner of Japan where he and his staff worked, British prestige was at its zenith; and as regards the popularity of the personnel, it may be mentioned that when Colonel and Mrs. Sempill left Kasumigaura, every man, woman and child subscribed to the farewell presents and entertainments given in their honour. It is agreed that the Mission did much for Japan; I suggest, with no fear of contradiction, that they did much for England too.

Sir EDWARD CROWE, K.B.E., Commercial Attaché to H.B.M. Embassy, Tokyo (*communicated*): As the representative of British commercial interests in Japan I would like to contribute my mite to the discussion. There is no doubt that Colonel the Master of Sempill's Mission to Japan had a very important effect on British trade. In statistics of imports and exports it is often impossible to include figures relating to purchases made by Government departments, and, in this particular case, no record appeared in the Japanese statistics of the very large purchases of British materials which were made through Colonel Sempill's instrumentality. Both Great Britain and Japan were doubly fortunate in having Colonel Sempill as the head of this Mission. Thanks to his great knowledge and experience, Great Britain was able to dispose of a certain amount of material which was in excess of our requirements, while the Japanese procured the very best quality which was to be found anywhere, and at an extremely reasonable price. The result of this has been that Japanese purchasers of aviation material will in future turn more and more to British suppliers, and we ought, all of us, to be thankful to Colonel Sempill, not only for what he has done in maintaining British prestige in Japan, but in affording our manufacturers of aviation material better opportunities for disposing of their goods in a friendly market.

On the motion of the CHAIRMAN, a very hearty vote of thanks was accorded Colonel the Master of Sempill.

Colonel the MASTER OF SEMPILL, A.F.C., in responding, expressed his great thanks for the very sympathetic reception which had been accorded to his paper, and particularly to His Excellency the Japanese Ambassador and those others who had eulogised the work of the Mission in such flattering language.

He had found it impossible to deal with the work of the Mission in a short paper, and had therefore been compelled in the lecture barely to touch on some of the interesting features. He hoped, however, that there might be some who would be sufficiently interested to read the full paper at their leisure.

FURTHER NOTES ON AVIATION IN CANADA

BY C. W. STEDMAN, FELLOW.

In the Aeronautical Journal of September, 1922, the writer published an article setting out a brief description of the work that is being undertaken by aircraft in Canada, and describing more fully the details of the problems that were peculiar to the country, more particularly the technical work in connection with winter flying, and, in order to avoid repetition as much as possible, it is necessary to refer occasionally to that previous paper.

New Fields of Work

The various uses of aircraft as described before have been continued, and in no cases have any of the uses been discontinued on account of lack of success, although limitation of funds has in some cases prevented as much work being done as would appear to be desirable.

Aerial Surveying.—Very considerable advance has been made with aerial surveying, more particularly by means of oblique photography over country which is more or less flat; this includes very large tracts of country in Canada. This method of aerial surveying has been developed by Mr. A. M. Narraway, D.L.S.

Mapping from oblique photography allows very complete details being filled in with a minimum amount of ground work.

Let us assume that along a certain waterway a seaplane has taken a series of oblique photographs extending over a large number of miles. These photographs are usually taken directly ahead and then to the right and left of the machine, at an angle of depression of about $7\frac{1}{2}°$ from the horizontal, and include the horizon.

A print from each of the photographs is supplied to the surveyor, and he travels over the same country fixing the location of certain points along the route. He would endeavour to locate about three points on each photograph, suitably marking the photograph and his notes so that he can recognise the points selected.

On completion of this field work, he plots the points on his map, and upon the photograph from the known points and the horizon line it is possible to superimpose a perspective view of a grid, which in true plan is a series of squares. The squares are also located on the map, and by selecting points on the photograph from the co-ordinates on the distorted grid, they can be transferred to the squares on the map. In this way details can be very rapidly plotted on the map and with sufficient overlap of successive photographs the accuracy can be maintained. A typical grid photograph and map are shown in Fig. 2, and more complete details of the method are described in the Air Board Report for 1922.

The application of this method of utilising oblique photographs has permitted the mapping of the intricate mass of details along the important waterways of the north as well as enabling the more or less inaccessible areas on either side to be mapped with the same degree of accuracy. Then on top of the completed map the photographs enable the surface cover to be superimposed. The resultant map is when finished very complete and true to conditions on the ground. The cost is not high and is practically only that of the film, prints and plotting when associated with forestry patrols.

Forestry Protection.—The importance of aircraft for fire detection has now been fully demonstrated, and one of the recommendations of the recent British Empire Forestry Conference reads as follows :—

> " We are impressed not only with the value but with the necessity of using aircraft in protecting the forests of the inaccessible and uninhabited north country of Canada, where absence of means of transportation and communication prohibits fire detection or quick action on fire starting by any other means. The use of aircraft is fundamental to fire protection in such cases because only by their use can access to the location of the fire be obtained within a period of time short enough to permit of successful efforts at control."

It has, however, been shown that the amount of flying required for the protection of the enormous areas of forest in the country is so great that the cost of operation must be cut to the absolute minimum. When the work was in

FIG. 1.

Camera Mounted for Oblique Photography.

its experimental stages, the use of large machines with high-power engines was justified, particularly as it was desired to carry as many people as possible on each trip in order to convince them of the possibilities, but now that the commercial side has to be considered it is necessary to reconsider the whole method of operation.

It has been suggested by forestry engineers that the machines required for the purpose should be two-seater boats or pusher seaplanes, with air-cooled engines of less than 200 h.p., but as fire detection simply requires that one pair of eyes should be carried over the area to be patrolled, and as each additional man means increased expense of operation, it is the writer's opinion that this work can be done by a single-seater boat equipped with radio communication.

The recent interest in light aeroplanes should produce small engines that will be entirely suitable for this class of machine, and allow the expense of operation to be reduced many times below the present cost.

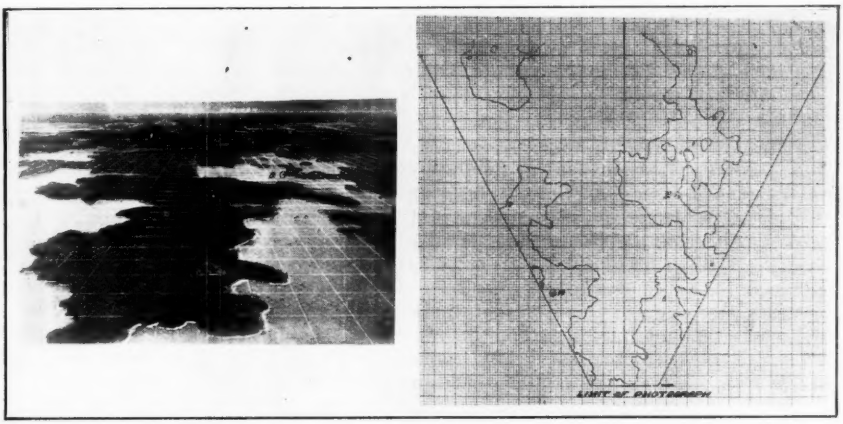


FIG. 2.
Oblique Photograph and Grid.

Progress of Research

The work of the Air Research Committee and of the Royal Canadian Air Force has been mainly directed to winter flying, and much progress along these lines has been made. Referring to the previous paper mentioned above, the progress made under the headings there given will be detailed below.

Engine Cooling.—The desirability of air-cooled engines remains unchanged. Unfortunately no engines of this type, other than low-power rotary engines, have been available, but it is hoped that the situation may improve in the future.

With water-cooled engines it has been found that should the necessity arise, water can be used in the cooling system by the exercise of great care along the lines previously discussed, but for routine work it is much better to use a suitable anti-freeze mixture. A mixture of denatured alcohol and water has been found to be very satisfactory, especially as its freezing point can be found at any time by measuring its density with a hydrometer and its temperature and so determine its freezing point from a chart which is easily prepared.

The disadvantage of this cooling medium lies in its low boiling point, especially at a height above sea level. This difficulty has been largely overcome by an ingenious device made by officers of the Royal Canadian Air Force.

The usual vent from the radiator is closed, Fig. 3, and a pipe is carried from the filler cap through a cooling coil and discharges below the surface of the liquid in an auxiliary tank which is also open to the air. On starting up the engine as soon as the anti-freeze mixture begins to boil, the vapour is condensed and either goes back into the radiator or is discharged into the tank. Any increase in volume of fluid in the tank means a corresponding decrease of pressure in the radiator under normal temperature conditions, so that on throttling the engine to glide and consequent cooling of the radiator, the excess fluid in the tank is sucked back into the radiator, thus preventing the loss of volume which otherwise would occur. This device has also been found to work well on the writer's automobile, no smell of vapour being noticeable when the liquid in the radiator is boiling violently and practically no loss of liquid taking place.

Radiator Systems.—It was previously pointed out that it was very desirable to have a radiator which would not be liable to fracture if it should be accidentally frozen. Such a condition is liable to occur even with an anti-freeze mixture if a sudden cold spell comes along during which the temperature falls below the freezing point of the liquid in the radiator, for obviously it is undesirable to use a cooling mixture which is lighter than is absolutely necessary for the existing condition.

During the past winter, some very interesting tests on the freezing of radiators have been carried out by Professor Robb at Edmonton. A number of different kinds of radiators were obtained, and these were filled with water each day, placed in a rack in the open air and allowed to stay out all night. In the morning each radiator was taken in and plunged into a bath of hot water to thaw out. After thawing out, the radiators were each tested for leaks, and examined. Any defects found were repaired in the simplest manner possible and the tests repeated. The results of these tests show that certain radiators are much less damaged by ice than others. The standard horizontal round-tube radiator is particularly bad, being frequently broken away from the tank in a manner that makes a repair in the field practically impossible.

The best form of radiator would appear to be one in which the water flows in a zig-zag tube from the top tank to the bottom tank, and on which there are no side tanks or side stiffeners. The design of the water tanks at top and bottom also requires special attention.

Engine Lubrication.—Routine winter flights have been carried out with a Rolls-Royce engine, using a light Arctic oil and without any warming up of the oil before starting, with very satisfactory results. It is thought that by carefully selecting the oil to suit the climatic conditions, no difficulty will arise, but it should be remembered that in these tests the cooling was by means of an anti-freeze mixture, so that the temperature of the engine during flight did not rise to the temperature usual with water cooling.

Engine Starting.—During three previous winters, Professor Robb has studied the question of cold-weather starting, and his results have been summarised into definite instructions to suit the various temperature ranges (see Appendix to previous paper).

This work has been used during the past winter in carrying out routine winter flights with satisfactory results.

The main points brought out during this work are :—

(1) The necessity for easing up the engine with preliminary doping with gasoline and considerable turning over with the switches off. This

to be repeated until it is considered that a sufficiently good swing can be made for starting.

(2) The necessity for doping with a *measured* quantity of dope (in this case gasoline and ether) in order that there may be no uncertainty as to whether the engine is over-doped or under-doped.

(3) The necessity for fitting the doping pump right over the engine, and so reduce the leads to a minimum. A long dope pipe means uncertain starting.

(4) The necessity for fitting air chokes to the carburettor to enable the engine to be kept running after it has once fired.

(5) The value of any heat, however obtained. A good way to warm an engine in the field is to place a cover over it and then fit a stove pipe into the cowling at an angle from some distance away and place a blow lamp so as to project the flame towards, but not into, the open end of the stove pipe.

(6) Due to increase in viscosity of the gasoline with decrease of temperature, it is necessary to adjust the carburettor jets to suit the existing temperature conditions.

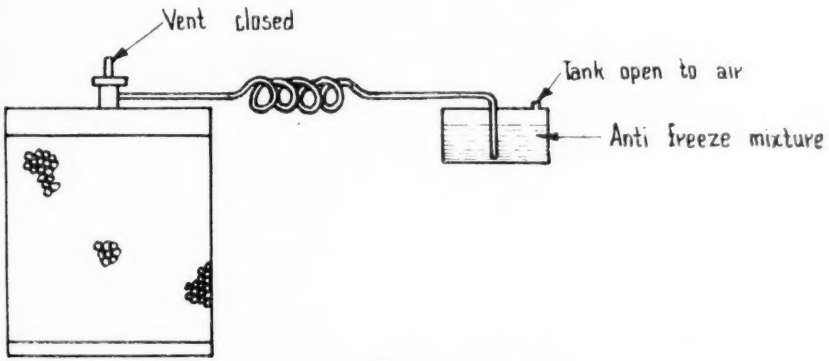


FIG. 3.
Radiator for Winter Flying.

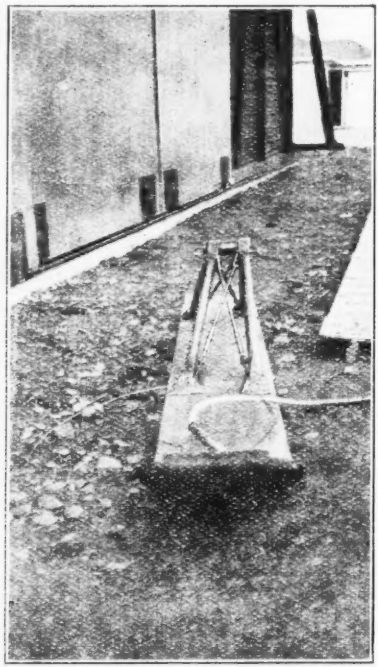
Winter Landing Gear—Skis.—The design of skis has been materially improved, and the reasons for certain alterations have been investigated.

Loading.—During the past winter a D.H.4 machine was mounted on skis having a loading of 200 lbs. per sq. ft. of bearing surface. This machine was tested at High River, Alta., where there was about ten inches of fine powder snow and a temperature from — 10° to — 20°F.

It was found that with this loading and these particular snow conditions the skis would at low speeds dig down on to the earth surface, the action being assisted by the propeller blast, which easily blew the snow away. If the speed was increased rapidly, there was very little difficulty, but it was decided that a loading of about 150 lbs. per sq. ft. would be better under these conditions, because if once a machine got through the snow to the ground, considerable assistance was necessary in order to move it.

Bottom Boards.—No surface for the bottom boards has been found which is superior to a sheet of duralumin, but this must be continuous from end to end and carried around the sides, so that there are no edges exposed to the snow.

Design of Fittings.—The fittings used are shown in Fig. 4. These are of conventional design, except that all cable has been replaced by solid steel rods in order to eliminate the spring that otherwise exists.



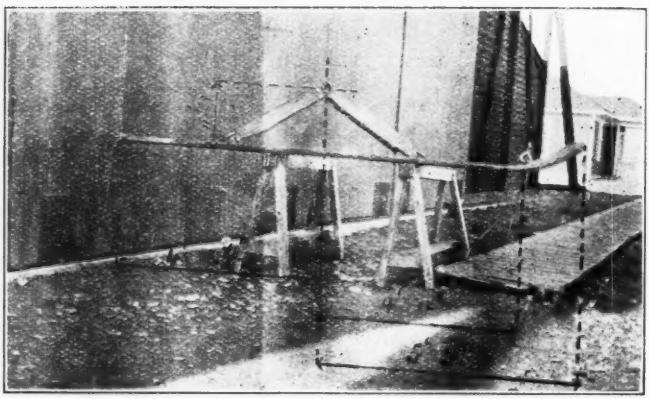


FIG. 4.
Skis for D.H.4 Machine.

The skis have been designed for a vertical load of four times the weight of the machine and to a simultaneous load equal to the weight of the

machine applied horizontally at the axle. This has been found to give satisfactory strength and may be reduced later, but so far only experimental work has been carried out, and weight has been purposely sacrificed for safety.

Position of Axle.—The position of the axle has been changed many times, but only recently has any theory on this subject been considered.

The following points are put forward to explain the present ideas on this subject.

Consider first the analogy to be obtained from human skis. An aeroplane turning with a steerable tail skid on the surface can be compared to a man executing a steered turn on skis in which it is known that the rudder ski must be weighted, but not necessarily as heavily as the other ski; hence these conditions are fairly well met in the case of the aeroplane, except that the tail ski must have good resistance to side-slip whereas the main skis must be free to side-slip.

Let A and B be the main skis of an aeroplane, and C the tail ski; also assume that the aeroplane is travelling tail down on a straight course, and that the tail ski has just been turned in order to start a turn.

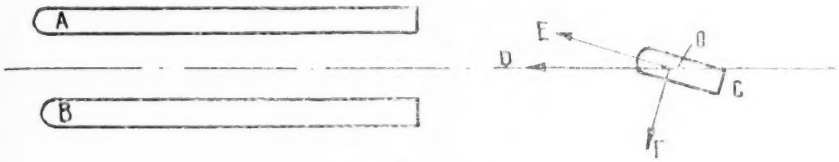


FIG. 5.
Turning with Tail on Ground.

The thrust will act along the axes of the main skis, but the force OD due to thrust on the tail ski can be resolved into two components OE in the line of the tail ski, and OF at right angles to it.

The tail ski must be designed so that there is a minimum of resistance to sliding in the direction OE, and as much resistance as is practical to sliding in the direction OF. Then the tail ski will tend to move in the direction OE and so start to turn the machine, but in order to do this the main skis must be correctly loaded and free to side-slip, and in this respect aeroplane skis must differ from human skis. Aeroplane skis must be designed to side-slip.

Now consider the case of an aeroplane travelling at high speed with the tail ski off the surface. Any slight change of direction is equivalent to a turn and must be considered as such. Under these conditions the main skis must change direction by side-slipping under the action of the air rudder.

The question now arises as to how best to design the main skis so that they will side-slip. Reference is again made to the human ski, where it is well known that in order to side-slip a ski successfully it is necessary for the weight to be on the toe of the foot because the toe-fitting is arranged at the centre of resistance to side-slip of the ski.

Consider a uniform plank lying on the ground. If it is required to push the plank sideways, pressure is applied at the centre of side area as at A, then the plank will move parallel to itself (Fig. 6).

If the force had been applied at a point further forward as at B, Fig. 7, the toe of the plank would move more than the heel and conversely if the force had been applied behind the centre of side area.

This principle is made use of in the pure Christiania turn, in which the skis are kept parallel, and turning is obtained by a body swing with the weight on the toes to allow free skidding. If the heels are weighted too much, the skis tend to turn too far and travel backwards.

An aeroplane turn is a turn on the flat, with the skis parallel, brought about by an applied couple due to the air rudder.

If a turn to the left is required, a force to the right and behind the centre of gravity is applied by means of the air rudder. For turning to take place, the heels of the skis must side-slip to the right relatively to the toes of the skis. Therefore, the weight on the skis must be at least as far back as the centre of resistance to side-slip and probably further back still, for if the weight were further forward, the toes of the ski would tend to turn to the right as in case B, and so counteract the turning couple due to the rudder.

FIG. 6.

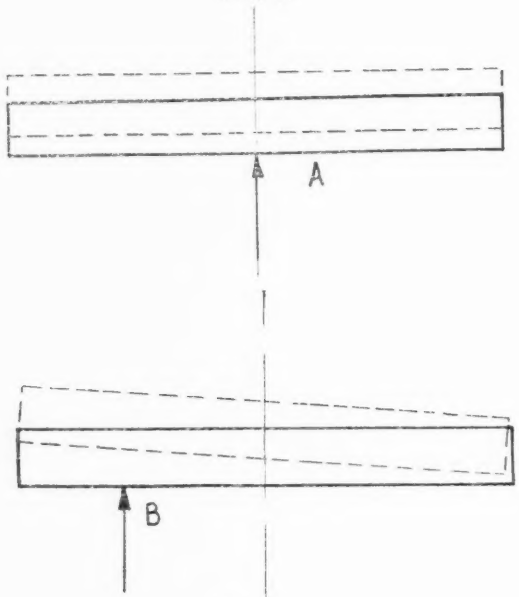


FIG. 7.

In previous tests, skis have been designed to have the axle approximately at the centre of bearing area, which is also the centre of resistance to side-slip, and at various times it has been found that the performance of the skis has been improved by cutting down the area aft of the axle. The reason is now obvious, for, with the engine on, the line of reaction through the axle is not vertical due to the weight, but is inclined forward due to the resistance of the ski which must be overcome by the thrust, and also to the force required to accelerate the skis themselves.

By assuming a value for the coefficient of friction, it is possible to plot the most forward position of this line of reaction, and place the axle so that this

line cuts the bottom board at the centre of the bearing area. Then for any other condition of loading, the load applied to the ski will always be behind the centre of bearing area and allow for heel weighting.

In order that side-slipping may be free, it is necessary to eliminate anything in the form of fore and aft grooves, and it has also been found advantageous to round off the bottom edges of the skis. It might even be desirable to curve the whole lower surface so that the tendency of the ski is to ride up on the surface of the snow during side-slip, but this latter expedient has not yet been tried. It is thought that such a curved ski would prevent the burying due to side motion that was mentioned in the previous paper.

Flying with Skis.—When fitting skis to the machine, check wires are placed at each end to limit the angular motion of the skis, and in addition a strong piece of shock-absorber cord is placed to hold the front end of the ski up into a position convenient for landing, *i.e.*, about horizontal.

On approaching the ground to make a landing, the tail of the machine and consequently the heels of the skis are relatively low, so that the slightest touch of the heels of the skis can be felt and gives a warning to the pilot, besides having a certain amount of shock-absorbing effect due to the considerable travel of the heels of the skis and stretching of the front rubber cords. It is considered to be easier to make a good landing with skis than with wheels, for with wheels any touch bounces the machine up again, whereas with skis a similar touch would merely cause rotation of the skis, without any appreciable effect on the machine.

Up to the present, no effect on the flying qualities of the machine due to the additional area of the skis forward of the C.G. of the machine has been noticeable.

Skis for Flying Boats.—Experimental skis for an amphibian type flying boat have been built. These are excessively heavy due to the height of the axle from the ground in this particular machine.

Unexpected difficulties have been encountered due to the large moments about a vertical axis that are liable to occur with skis, and which do not occur with wheels. These moments are of small importance in an undercarriage having a straight-through axle, which, being usually tubular, is strong enough for any moment that may be applied by the ski.

Temperature Effects on Rigging.—In confirmation of previous experience, it has been found that with machines of combined wood and metal construction subjected to large changes of temperature, it is necessary to adjust all bracing wires under the cold conditions, as otherwise a machine that has been rigged while warm will be badly strained when subject to a very low temperature due to the greater contraction of the metal parts.

Temperature Effects on Rubber Shock Absorber.—It is now well established that the properties of rubber shock-absorber cord are considerably affected by change of temperature, and tests of this effect have been carried out in England. This work has been extended in Canada, where climatic conditions allow such test to be carried out.

Fig. 8 shows the stress-strain curve for a piece of $\frac{3}{8}$in. diameter rubber cord made to Air Ministry specification, test being made at temperatures from 70°F. down to 1°F.

An extended research on this effect is now being carried out.

Conclusion

During the past winter routine flights have been made throughout the coldest weather without any insurmountable difficulties being encountered.

The pilots' instructions were that they were to climb to 10,000ft. above

the aerodrome (itself at 3,000ft. above sea level), then fly around until they were satisfied that the flight could be continued, then to come down and land. Each pilot made a written report of temperatures and other points noted, and the unanimous opinion has been that there is nothing difficult about this work after the engine has once been started, if the pilot is properly clothed and the cockpit is well screened.

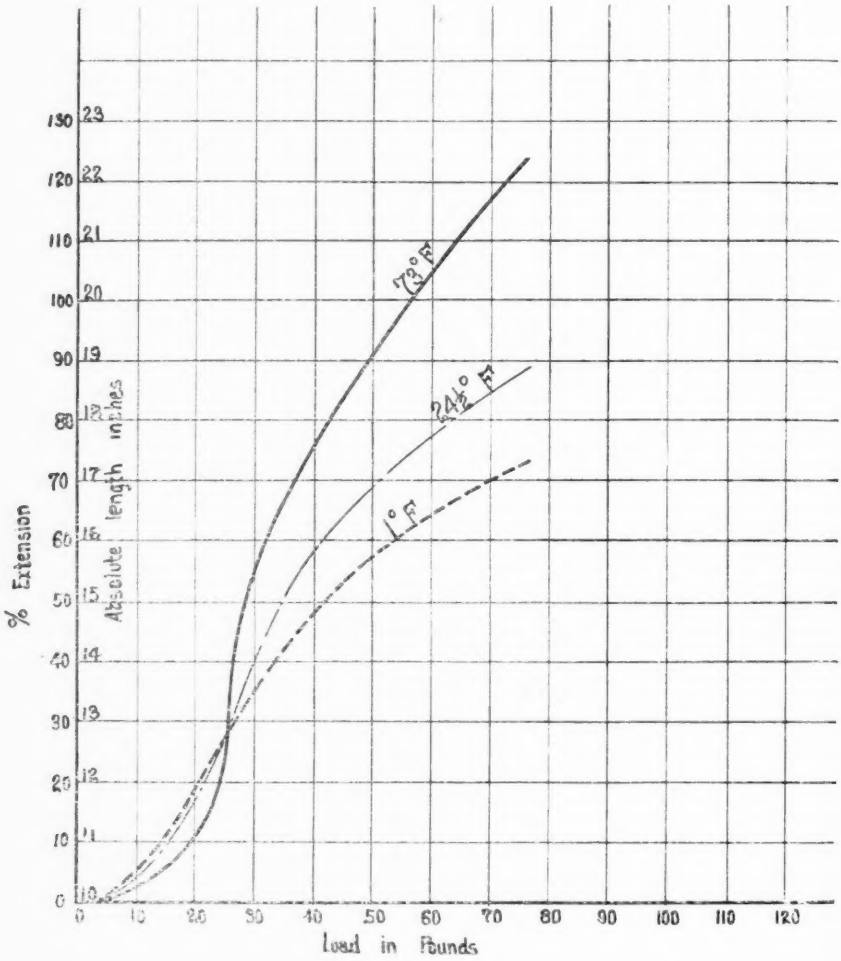


FIG. 8.

From these results it would seem to be possible at this time to design machines that would be in every way suitable to cold-weather flying.

This work has only been made possible by the advice of the members of the Air Research Committee and the hearty co-operation of the officers and men of the Royal Canadian Air Force.

REVIEWS

Optical Methods in Control and Research Laboratories

Vol. I., 2nd Edition. "Spectrum Analysis, Absorption Spectres, Refractrometry, Polarimetry." Goldsmith, Judd Lewis and Twyman. Adam Hilyer, Ltd.

A twofold point of view is emphasised, first, that a sound knowledge of the physics of the methods is essential to high grade work, and second, that in actual measurement the ideal instrument performs the maximum possible amount of reduction to the desired scale, the time thus saved on "reductions" being available for study of the underlying principles.

Brief but reliable historical notes and extensive references to the apposite literature lead up to the purely advertisement function of the brochure with respect to the publishers' optical instruments.

This method gives a stimulating effect of reality to an admirable piece of rational publicity.

A. R. L.

Aeronautical Prints and Drawings

With Text by Lieut.-Colonel W. Lockwood Marsh and Foreword by Major-General Sir Frederick Sykes. 1924.

In a review which appeared in this journal in December, 1922, on the publication of "L'Aéronautique des Origines à 1922"—a fine volume mainly due to the admirable enthusiasm of MM. Paul Tissandier and Charles Dollfus—the hope was expressed that the book would "inspire some English publisher to undertake a similar enterprise." Whether the present work owes its inception at all to that suggestion is of no moment—it may in any case be gratefully accepted as a notable contribution of its kind, to the study of aeronautical engravings and the tale they help to tell. For that reason Colonel Lockwood Marsh and his publishers are to be congratulated on the production of this handsome quarto volume. If it should serve to stimulate public interest in aeronautical matters—and it may be that a real awakening to the immense significance of aeronautics in relation to the British Empire will result from an increased interest in past history hardly less than from present-day achievements—they will deserve a twofold share of congratulation. Incidentally it is of interest to recall that some such aim was put forward by Hatton Turnor in a prospectus issued (as a leaflet in the monthly parts of "Our Mutual Friend") prior to the publication as far back as 1865 of his oft-quoted compilation "Astra Castra." With some slight modification his words are, unfortunately, so applicable at the present juncture as to deserve quotation: "The Author trusts that when full publicity shall have been given to the comparative rarity of accidents, and the causes whence they have arisen, many persons may be induced to avail themselves of that enjoyment of nature, from which so many are now deterred by the apprehension of personal danger."

Turning to the actual contents of the present book—which is happily of a very different character from "Astra Castra"—it is in no sense disparaging to regard it as intended primarily for the collector. Collectors of all classes, whether of books, china, engravings, or anything else, may have their vagaries, but at least their endeavours result in the preservation of the objects collected, and those concerned with aeronautical history—to take a pertinent case—are greatly indebted not less to collectors of the past than to those of to-day. This work bears ample witness in particular to the diligence of collectors of aero-

nautical prints—to an extent indeed that must have made the task of selection one of no small difficulty. It can only be said that broadly speaking the volume certainly does afford to collectors a representative selection and the reproductions are excellent throughout. Of the coloured plates, those of the ascents of James Sadler (the frontispiece and No. 71) are good examples of the finest coloured aquatints of English ballooning subjects. On the other hand the crude Turneresque painting of Blanchard's Channel Crossing in 1785, by E. W. Cocks—who was a scenic artist at Vauxhall Gardens in 1836 and probably did this picture at an even later date—is representative neither in an artistic nor historic sense. In the matter of "states," which is always one of interest to collectors of engravings, Colonel Lockwood Marsh has rightly made a point of illustrating a few of the many instances where one plate was subsequently made to serve for later and quite different events.

But if the selection of subjects was difficult—by reason of the large number of extant prints on the one hand and of limitations of space and so forth on the other—the writing of the text was hardly more easy, and was perhaps bound to be in some measure an unsatisfactory task. Nearly every plate recalls features of interest either from a biographical, anecdotal, or technical point of view, whereas the exigencies of space forbade more than a brief allusion. Otherwise—to take a single instance—the reference to James Sadler, of Oxford, who was undoubtedly the first English aeronaut in the full ballooning sense, and who has not yet been accorded adequate recognition as a pioneer, must have been deemed insufficient. His early endeavours with both hot air and hydrogen balloons were not only in themselves remarkable, but Sadler proved himself a balloon pilot of ability and character, while his work as an inventor of improvements on the steam engine is of more account than his origin from a family of confectioners. But such omissions in the text, as also relative gaps in the illustrations, were doubtless inevitable. Colonel Lockwood Marsh has succeeded, nevertheless, in putting together some notes which serve at once as introductions to the particular prints here reproduced and to other engravings of the same subjects. It is, however, regrettable—having regard to the character of the volume and to the fact, as aforesaid, that it marks a notable advance on previous British contributions to the subject—that the proofs were not more carefully revised. "Entrepenant," "Tuilleries" and "Gilray" are amongst other misprints which should have been avoided. Less excusable is the mis-spelling of the name of Dr. Jeffries (a perennial error) and of that of M. Paul Tissandier, as they are both given correctly in another place, and the two forms "Le Flesselle," adopted from print (p. 14) and "Le Flessell" (p. 17) would have been more correct as "Le Flesselles." But these small errors need deter no reader from studying or—according to his inclination—enjoying a book, the publication of which may, perchance, act as a spur to others.

The fact that the Secretary of the Royal Aeronautical Society has taken up his pen to write on the "historico-pictorial" aspects of aeronautics, is itself significant. As Sir Frederick Sykes remarks in his "Foreword," the subject has hitherto been generally neglected in this country—where, it must be added, the more important historical aspects have also been unduly ignored. Is it permissible to hope that Colonel Lockwood Marsh will not rest content until he has produced an adequate history of the Society's most interesting and important endeavours in the cause of aeronautical development during the last fifty years?